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ABSTRACT

The syllabus outlines material for a course two academic years in length (minimum two and one-half hours daily experience) leading to entry-level occupational ability in several welding trade areas. Fourteen units covering are welding, gas welding, oxyacetylene welding, cutting, nonfusion processes, inert gas shielded-arc welding, welding cast iron, welding stanless steel, pipe welding, and plasma welding (optional) are presented in a three-column format. The first column lists the topics of instruction for each unit. Cognitive, affective objectives, and behavioral objectives corresponding to the topics are provided in the second column. The third column describes specific teaching activities for presenting the topics. Appended are a resource list of books, a list of audio-visual software with sources, a suggested group of tools and equipment necessary for a trade course in arc and acetylene welding, information on eye safety, and the procedure for obtaining welding certification in New York State. (MS)

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1975 REPRINT

TRADE WELDING

syllabus

THE UNIVERSITY OF THE STATE OF NEW YORK / THE STATE EDUCATION DEPARTMENT
BUREAU OF SECONDARY CURRICULUM DEVELOPMENT / ALBANY, NEW YORK 12224
1972

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SYLLABUS

IN

TRADE WELDING

THE UNIVERSITY OF THE STATE OF NEW YORK/ THE STATE EDUCATION DEPARTMENT
BUREAU OF OCCUPATIONAL AND CAREER CURRICULUM DEVELOPMENT/ ALBANY, NEW YORK 12234

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Carl G. Benenati

FOREWORD

The proliferation of course offerings in welding since 1965 has mandated creation of a State standard for this curriculum.

During July 1969, welding instructors Ivan Griffin, Central Technical High School, Syracuse, and Stephen Polniak, Trott Vocational High School, Niagara Falls, met with Edward Shattuck, associate, Bureau of Trade and Technical Education, to construct a topical outline of course content. The following August a committee comprised of James Kearns, Warren County BOCES; Richard Kelly, Albany (city) Vocational Center; and Hans Weber, Ulster County BOCES, guided and assisted by Joseph Messier, Associate in Vocational Curriculum, expanded the topical outline into this syllabus in trade welding.

The syllabus, like other syllabuses, presents required content arranged in some logical, but not necessarily teaching, sequence. Due to the high degree of personal skill which a welder must develop, it does not require that each student become acceptably proficient in every area of the content, but allows for individual rates of progress and attendant certification of proficiency in specific trade areas. Neither does it preclude participation by students of other trades in those segments only, which are considered to be part of the job of their journeymen, such as the light gage steel welding performed by carpenters in some areas. These aspects should be carefully considered by the teacher when using the syllabus in developing a course of study.

Excerpts from the USA Standard Practices for Occupational and Educational Eye and Face Protection are included for the teacher's convenience. Information regarding Welder Certification testing, pages 37 through 49, is provided through courtesy of the New York State Department of Transportation.

G. Earl Hay, *Chief*
Bureau of Occupational and Career Curriculum Development

Gordon E. Van Hooft, *Director*
Division of Curriculum Development

TO THE TEACHER

This syllabus in trade welding is organized on the basis of a minimum daily experience of 2 1/2 hours, through 2 academic years of 165 teaching days each. The content is devoted mainly to the basic, required arc and acetylene welding and the increasingly important shielded-arc processes, but includes as an optional unit the locally important plasma welding. It is expected that the individual welding instructor will adapt the content to his teaching situation when preparing his course of study.

A three-column format was adopted for this syllabus; the first column consisting of the units of instruction. The second column lists the objectives of the instructional units, divided into two groupings. One group, appearing under the heading "The student should be:" is concerned with background and related knowledge, the acquisition of which must be evaluated subjectively. The second group, titled *"The student should be able to:"* combines these cognitive and affective values with the more objective psychomotor learning, expressed in performance terms which describe a test of the learning. The final column consists of suggestions intended to aid the teacher in delimiting the depth or breadth of instruction, and to stimulate his ingenuity in varying methodology to meet the needs of every student.

The successful student of the course will possess entry ability in at least one of the trade areas classified and described in the U.S. Office of Education publication, *Vocational Education and Occupations:*

Welding and Cutting	17.2306	Combination Welding	17.230603
Gas Welding	17.230601	Brazing and Soldering Operations	17.230604
Electric Welding	17.230602	Welding and Cutting, Other	17.230699

Appended to the body of the syllabus is a resource list of books, A/V software, and their sources, a suggested group of tools and equipment necessary for a trade course in arc and acetylene welding, information on eye safety, and the procedure for obtaining welder certification.

Carl G. Benenati, *Chief*
Bureau of Trade and Technical Education

Robert H. Bielefeld, *Director*
Division of Occupational Education Instruction

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TRADE WELDING

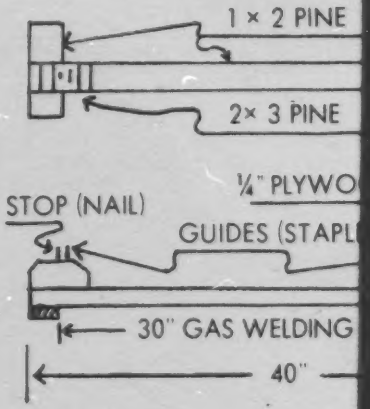
Instruction	Objectives	Teaching Suggestio
/Unit I — **ORIENTATION TO WELDING CAREERS**		
o History of Welding - Increasing use of metals - Improved technology . General . Welding	The student should be: Acquainted with the extent and importance of the welding industry.	Tracing forge-welding from Egyptian jewelry, through Damascus sword blades, to assembled tanks is usually
o Career Opportunities - Industrial - Trade - Technical - Sales - Engineering	Acquainted with the occupational choices in the welding field.	Films of welding being don various settings are avail
o Employment Opportunities - National - Regional - Local	Aware of the standard of living possible through welding occupations.	Screen "want ads," union a industry personnel literat Department of Labor foreca opaque projector (transpar overhead projection can be less impact).
o Shop Organization - Daily routine - Fire procedures . Building evacuation . Nature and use of extinguishers - Course outline . Content . Standards of competency . Methods of evaluation	*The student should be able to:* Demonstrate by any teacher-designated means an understanding of procedures to be followed and a knowledge of basic rules of school and shop.	Handout sheets, clearly ar stating the basics involv value. Minor details sho in discussion.

TRADE WELDING

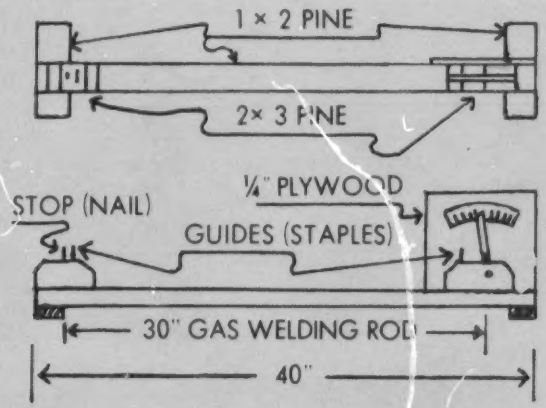
	Objectives	Teaching Suggestions
ON TO WELDING CAREERS		
ng of metals logy	The student should be: Acquainted with the extent and importance of the welding industry.	Tracing forge-welding from prehistoric Egyptian jewelry, through strip-welded Damascus sword blades, to modern weld-assembled tanks is usually effective.
ties	Acquainted with the occupational choices in the welding field.	Films of welding being done in various settings are available.
rtunities	Aware of the standard of living possible through welding occupations.	Screen "want ads," union and industry personnel literature, and U.S. Department of Labor forecasts in an opaque projector (transparencies for overhead projection can be made but have less impact).
on nation of	*The student should be able to:* Demonstrate by any teacher-designated means an understanding of procedures to be followed and a knowledge of basic rules of school and shop.	Handout sheets, clearly and concisely stating the basics involved should be of value. Minor details should be covered in discussion.
competency luation		

Instruction	Objectives	Teaching Sugges
/Unit II — **FUNDAMENTAL KNOWLEDGE**		
o Basic Ferrous Metallurgy - Production of iron . Mining the ore . Blast furnace production - Production of steel . Methods . Types Carbon Alloy . Properties	The student should be: Acquainted with the means by which iron and steel are produced. Aware of the importance of high temperatures in the production of iron and steel. *The student should be able to:* Demonstrate by any teacher-designated means a knowledge of those basic properties of commonly used steels which affect the welding/cutting process.	A variety of audiovisua available from many com The student should not memorize a list of stee should learn the proper steel at the time it is
o Principles of Welding - Fusion . Arc . Oxy . Resistance - Nonfusion . Brazing . Silver soldering	Demonstrate by any teacher-designated means a basic understanding of the nature of fusion, and the manner in which it is achieved with oxy and arc equipment. Demonstrate by any teacher-designated means a basic understanding of the nature of nonfusion, how it differs from fusion, and of the manner in which brazing and silver soldering is accomplished.	The student should be t acquainted with the pri oxy and arc welding. I only that he know of th resistance welding.
o Cutting - Type . Flame . Arc - Means . Manual . Machine	The student should be: Aware of the welder's ability to separate as well as join metals. Acquainted with both machine and hand-held equipment.	

	Objectives	Teaching Suggestions
DAMENTAL KNOWLEDGE		
s Metallurgy of iron e ore ace production of steel	The student should be: Acquainted with the means by which iron and steel are produced.	A variety of audiovisual software is available from many commercial sources.
	Aware of the importance of high temperatures in the production of iron and steel.	
	The student should be able to: Demonstrate by any teacher-designated means a knowledge of those basic properties of commonly used steels which affect the welding/cutting process.	The student should not be required to memorize a list of steels/properties. He should learn the properties of a specific steel at the time it is used.
Welding	Demonstrate by any teacher-designated means a basic understanding of the nature of fusion, and the manner in which it is achieved with oxy and arc equipment.	The student should be thoroughly acquainted with the principles of oxy and arc welding. It is necessary only that he know of the existence of resistance welding.
lering	Demonstrate by any teacher-designated means a basic understanding of the nature of non-fusion, how it differs from fusion, and of the manner in which brazing and silver soldering is accomplished.	
	The student should be: Aware of the welder's ability to separate as well as join metals.	
	Acquainted with both machine and hand-held equipment.	

Instruction	Objectives	Teaching Suggestion
o Heat Sources - Oxyacetylene - Electricity - Oxyhydrogen - Air/acetylene - Air/fuel gas	The student should be: Acquainted with the various sources of welding energy. *The student should be able to:* Demonstrate by any teacher-designated means a thorough understanding of those properties of oxyacetylene and electrical energies which affect the welding process.	The student should thorough oxyacetylene and electric It is sufficient for this student be acquainted with of oxyhydrogen, air/acetyle gas systems.
o Effects of Heat - Expansion - Contraction - Conditioning . Hardening . Annealing . Normalizing - Stresses . Internal . External	The student should be: Aware of the relationship between temperature of metals and their dimensional stability. Aware of the different rate (coefficient) of expansion of different metals. Aware of the problems involved in heating and cooling cycles, and incorrect welding sequences. Acquainted with the processes of heat conditioning.	Construct a "dial indicato of plywood and lumber, pro asbestos. Heat rod.  Have students make chippi from reinforcing rods.

Objectives	Teaching Suggestions
The student should be: Acquainted with the various sources of welding energy.	The student should thoroughly understand oxyacetylene and electric arc welding. It is sufficient for this course that the student be acquainted with the features of oxyhydrogen, air/acetylene, and air/fuel gas systems.
The student should be able to: Demonstrate by any teacher-designated means a thorough understanding of those properties of oxyacetylene and electrical energies which affect the welding process.	
The student should be: Aware of the relationship between temperature of metals and their dimensional stability.	Construct a "dial indicator" from scraps of plywood and lumber, protected by sheet asbestos. Heat rod.
Aware of the different rate (coefficient) of expansion of different metals.	
Aware of the problems involved in heating and cooling cycles, and incorrect welding sequences.	
Acquainted with the processes of heat conditioning.	Have students make chipping chisels from reinforcing rods.



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Instruction	Objectives	Teaching Sugges
o Safety - Personal . Eye protection . Skin protection - Environmental . Ventilation . Screening nonwelders . Storage . Housekeeping - Accidents . Procedure . Reports	*The student should be able to:* Demonstrate by personal behavior an appreciation of the need for constant safety procedure.	Display safety films, p National Safety Council Anecdotes from the teac experience are usually The student should be f school accident report tion required, and its
o Blueprint Reading and Sketching	Demonstrate by any teacher-selected means an ability to interpret welding drawings and to prepare freehand welding sketches.	The student should not memorize symbols but ra symbol for each type we practiced.
/Unit III — **INTRODUCTION TO ARC WELDING**		
o Equipment - Nomenclature - Function	Demonstrate by any teacher-selected means an ability to name the important parts of arc equipment and a basic understanding of the function of each.	Make handout sheets exp digital electrode class
- Fundamental Factors . Current setting . Length of arc . Rate of travel . Electrode angle	The student should be: Acquainted with the process of setting-up, and of striking an arc.	The student must unders of polarity, and its re electrode selection and

	Objectives	Teaching Suggestions
	The student should be able to: Demonstrate by personal behavior an appreciation of the need for constant safety procedure.	Display safety films, posters, and National Safety Council materials. Anecdotes from the teacher's industrial experience are usually quite effective.
		The student should be familiar with the school accident report form, the information required, and its possible effects.
	Demonstrate by any teacher-selected means an ability to interpret welding drawings and to prepare freehand welding sketches.	The student should not be required to memorize symbols but rather to learn the symbol for each type weld as it is practiced.

RODUCTION TO ARC WELDING

	Demonstrate by any teacher-selected means an ability to name the important parts of arc equipment and a basic understanding of the function of each.	Make handout sheets explaining A.W.S. digital electrode classifications.
Factors tting rc vel ngle	The student should be: Acquainted with the process of setting-up, and of striking an arc.	The student must understand the nature of polarity, and its relationship to electrode selection and job quality.

11A

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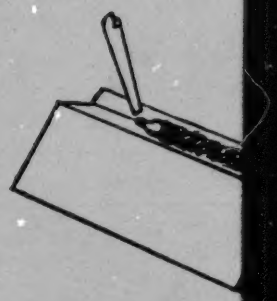
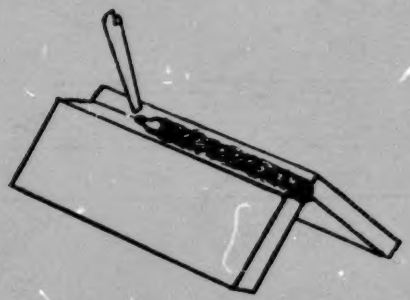
Instruction	Objectives	Teaching Suggestio
o Safety Orientation - Eye protection . Effect of rays . Approved filter plate . Head shield . Slag removal Hammer and chisel Wire brush - Skin protection . Sparks . Sunburn . Synthetic fabrics . Protective clothing	The student should be: Aware of the hazards inherent to, or attendant to arc welding. Acquainted with required procedures designed to minimize or eliminate the danger involved. *The student should be able to:* Demonstrate by any teacher-selected means an understanding of the danger-points of arc welding.	Note: Eye protection is r law for all who are vicinity of metal b formed. The student should the hidden dangers clothing filled wit fibers. Demonstrate the in certain synthetic igniting samples o sparks, molten met
o Welding; Student Flat Position - Familiarization with current controls - Positioning stock - Manipulating electrode and holder	Demonstrate by continual behavior a knowledge of proper safety procedures. Demonstrate increasing proficiency in setting up equipment. Demonstrate by any teacher-selected means an understanding of the effects of the four *Fundamental Factors* on the quality of the weld.	At this point the student experiment with the four Factors. Display samples of good a welds. Charts depicting are available from commer
- Adjusting apparel - Striking the arc - Running the bead	Demonstrate a beginning ability to strike an arc and run a bead.	The student should learn uniformity by sound as we appearance.
o Stringer Beads; Flat Position	The student should be: Aware of the importance of maintaining uniformity in arc length and rate of travel.	It is important that the proficient in use of diff electrodes and diameters.

Objectives	Teaching Suggestions
The student should be: Aware of the hazards inherent to, or attendant to arc welding.	Note: Eye protection is required by law for all who are in the vicinity of metal being cut or formed.
Acquainted with required procedures designed to minimize or eliminate the danger involved.	The student should be aware of the hidden dangers in *insulated* clothing filled with synthetic fibers.
The student should be able to: Demonstrate by any teacher-selected means an understanding of the danger-points of arc welding.	Demonstrate the inflammability of certain synthetic fibers by igniting samples of the cloth with sparks, molten metal, and flame.
Demonstrate by continual behavior a knowledge of proper safety procedures.	At this point the student should experiment with the four Fundamental Factors.
Demonstrate increasing proficiency in setting up equipment.	Display samples of good and of defective welds. Charts depicting weld defects are available from commercial suppliers.
Demonstrate by any teacher-selected means an understanding of the effects of the four *Fundamental Factors* on the quality of the weld.	
Demonstrate a beginning ability to strike an arc and run a bead.	The student should learn to judge bead uniformity by sound as well as by appearance.
The student should be: Aware of the importance of maintaining uniformity in arc length and rate of travel.	It is important that the student become proficient in use of different electrodes and diameters.

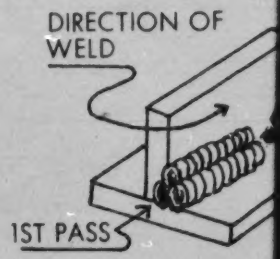
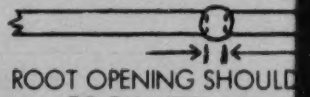
Instruction	Objectives	Teaching Suggest
	The student should be able to:	
	Demonstrate an ability to maintain uniform beads.	
	Demonstrate the ability to re-start an arc achieving total fusion and uniform appearance of the beads.	
o Padding; Flat Position - Bead overlap - Uniform height - Smooth surface - Stops and starts	Demonstrate an ability to adjust current settings for each rod size.	
o Corner Weld, Open and Closed; Flat Position - Hold to 90° corner - Tack ends	Demonstrate an ability to weld uniformly, with a smooth weld-to-plate transition.	
		The student should cons approximately 8 in. x 8 a nipple welded to one oil or water. Connect to test welds.
o Edge Joint; Flat Position - Tack ends - Full width weld . Uniform bead . Maintain existing plate edges . Fill craters at end of pass - Testing . Causes of defects . Means of avoiding defects	Demonstrate an ability to weld corner and edge joints without overlapping or eroding edges and without leaving craters. The student should be: Aware of the unfavorable results of slag included in the weld. Acquainted with the degree of penetration necessary.	The weld may be broken f surface inspection shoul weld.

Objectives	Teaching Suggestions
The student should be able to: Demonstrate an ability to maintain uniform beads.	
Demonstrate the ability to re-start an arc achieving total fusion and uniform appearance of the beads.	
Demonstrate an ability to adjust current settings for each rod size.	
Demonstrate an ability to weld uniformly, with a smooth weld-to-plate transition.	
Demonstrate an ability to weld corner and edge joints without overlapping or eroding edges and without leaving craters.	The student should construct a box, approximately 8 in. x 8 in. x 8 in. with a nipple welded to one side. Fill with oil or water. Connect compressed air to test welds.
The student should be: Aware of the unfavorable results of slag included in the weld.	
Acquainted with the degree of penetration necessary.	The weld may be broken for observation, but surface inspection should suffice for this weld.

Instruction	Objectives	Teaching Suggesti

/Unit IV —— ARC WELDING PRACTICE

Considering the broad scope of the welding industry —— space vehicle structures to skyscraper st any welding job has instructional value, if an industrial environment and industrial standards ar

o Fillet Weld; Lap Joint - Single bead - Multi bead . Bead sequence - Weaving the bead Distortion control - Testing	The student should be: Aware of the need to clean slag from the weld. *The student should be able to:* Maintain correct heat settings and electrode angle, and proper bead placement. Weld plates with one pass. Weld plates of different thickness. Demonstrate the ability to manipulate the electrode for "weaving."	 Observe: Welds should have unifo overlap, and smooth tra plate. Legs must be uniform. Beads should be slightl Demonstrate: Use of 5 percent nitric solution to test penetr
o Butt Weld; Square Edge	The student should be: Aware of the need to clean the weld. Acquainted with the appearance of proper penetration. Aware of the nature of "arc blow," and of the problems it creates.	The student should be awa effectiveness of this joi thicker than 1/4 in. must welded. 

Objectives	Teaching Suggestions

LDING PRACTICE

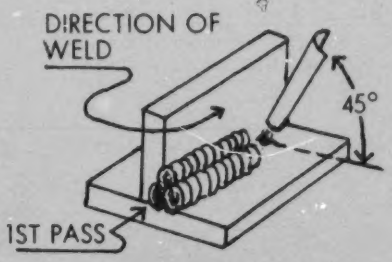
oad scope of the welding industry —— space vehicle structures to skyscraper structures —— s instructional value, if an industrial environment and industrial standards are maintained.

p Joint

The student should be:
Aware of the need to clean slag from the weld.

e
ad
ontrol

The student should be able to:
Maintain correct heat settings and electrode angle, and proper bead placement.



Weld plates with one pass.

Weld plates of different thickness.

Demonstrate the ability to manipulate the electrode for "weaving."

Observe:
Welds should have uniform angles and overlap, and smooth transition to plate.

Legs must be uniform.

Beads should be slightly convex.

Demonstrate:
Use of 5 percent nitric acid/alcohol solution to test penetration.

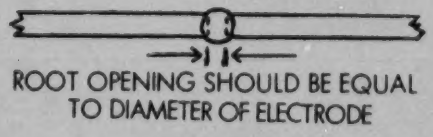
re Edge

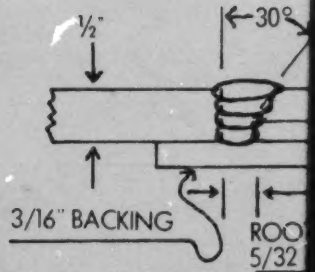
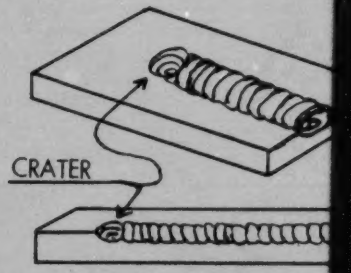
The student should be:
Aware of the need to clean the weld.

Acquainted with the appearance of proper penetration.

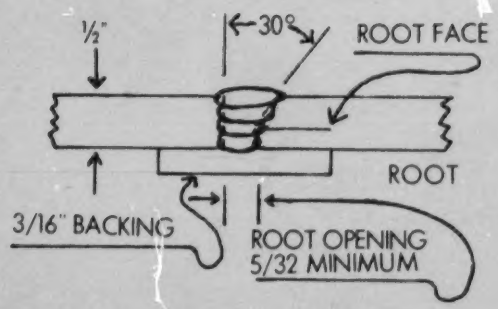
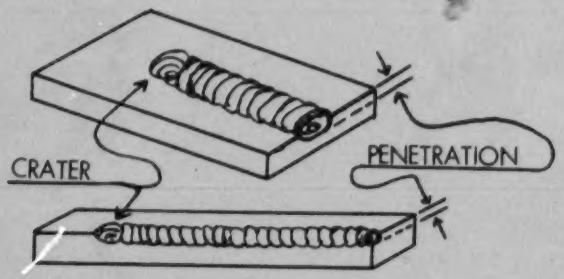
Aware of the nature of "arc blow," and of the problems it creates.

The student should be aware of limited effectiveness of this joint —— stock thicker than 1/4 in. must be groove welded.

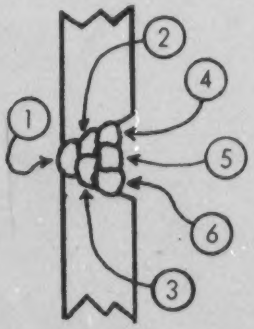


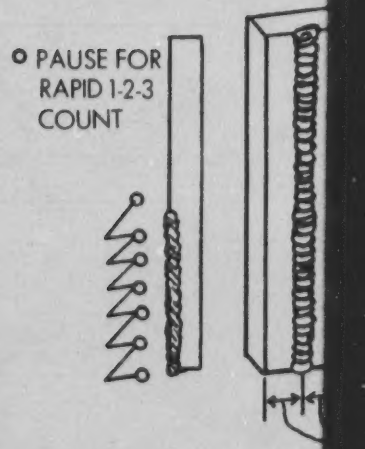
Instruction	Objectives	Teaching Suggesti
o Groove Weld; Flat Position - Terminology - Single V butt joint, single pass - Single V butt groove, multi pass . Backing plate - Weaving the bead	The student should be: Aware of the need to clean and bevel the plates. *The student should be able to:* Demonstrate by any teacher-selected means the ability to interpret trade terms. Demonstrate an entry-level ability to: . Clean and bevel the plates . Align the plates, tacking them in the proper sequence . Fuse the plates keeping the weld-face flat, without undercutting the sidewalls.	
o Stringer Beads; Horizontal Position - Positioning stock - Manipulating the electrode and holder . Angle to plate . Angle of travel - Striking the arc - Running the bead	The student should be: Aware of the gravitational pull on the molten bead, and the "fast-freeze" electrodes used to counter it. Acquainted with the necessary current settings. *The student should be able to:* Demonstrate ability to maintain the rod angle and rate of travel necessary to obtain uniform beads.	This procedure requires being the introduction t phase of welding. Instructor should requi beads in order to develo restart, insuring a smo weld. 

15

	Objectives	Teaching Suggestions
Flat Position tt joint, s tt groove, late bead	The student should be: Aware of the need to clean and bevel the plates. *The student should be able to:* Demonstrate by any teacher-selected means the ability to interpret trade terms. Demonstrate an entry-level ability to: . Clean and bevel the plates . Align the plates, tacking them in the proper sequence . Fuse the plates keeping the weld-face flat, without undercutting the sidewalls.	
ls; osition stock the nd holder late ravel arc bead	The student should be: Aware of the gravitational pull on the molten bead, and the "fast-freeze" electrodes used to counter it. Acquainted with the necessary current settings. *The student should be able to:* Demonstrate ability to maintain the rod angle and rate of travel necessary to obtain uniform beads.	This procedure requires close supervision, being the introduction to a more difficult phase of welding. Instructor should require full length beads in order to develop ability to restart, insuring a smooth continuity of weld. 

Instruction	Objectives	Teaching Suggesti
o Groove Weld; Horizontal Position - Single pass - Multi pass - Weave	The student should be: Aware of the critical importance of bead placement and cleaning. Aware of the need to maintain a uniform bead face.	The student should be abl of different thickness. Demonstrate "slag trap" f its effects on the weld q
o Stringer Beads; Vertical Position - Positioning stock - Manipulating electrode and holder - Striking an arc - Running a bead	Aware of the critical importance of voltage settings in this procedure.	





A TYPICAL

Objectives

The student should be:

Aware of the critical importance of bead placement and cleaning.

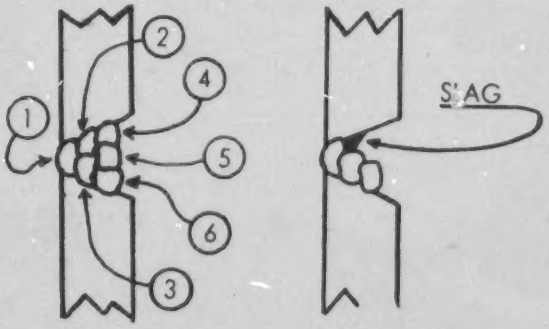
Aware of the need to maintain a uniform bead face.

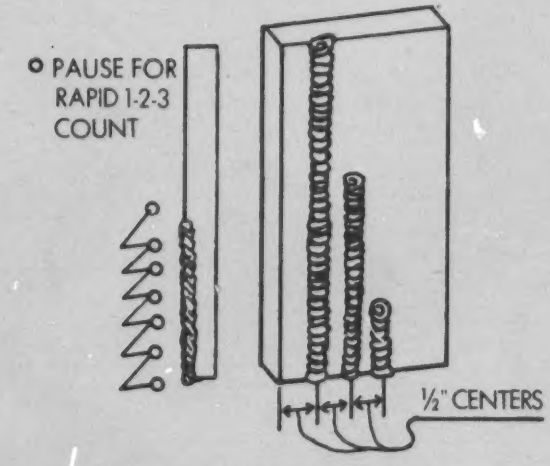
Aware of the critical importance of voltage settings in this procedure.

Teaching Suggestions

The student should be able to weld plates of different thickness.

Demonstrate "slag trap" formation and its effects on the weld quality.





A TYPICAL METHOD

16A

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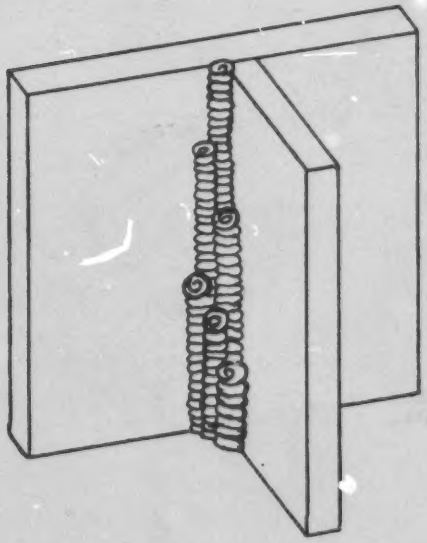
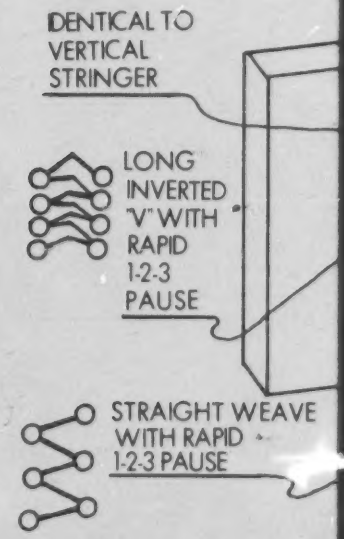
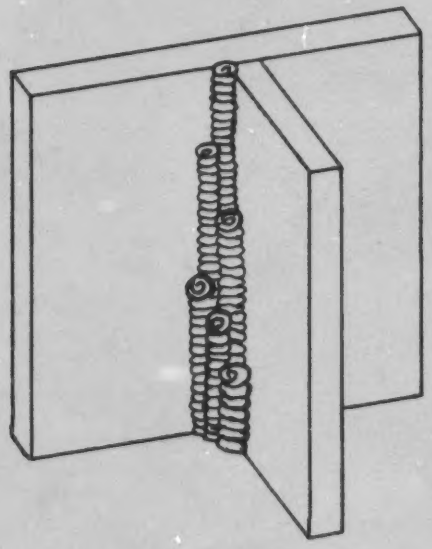
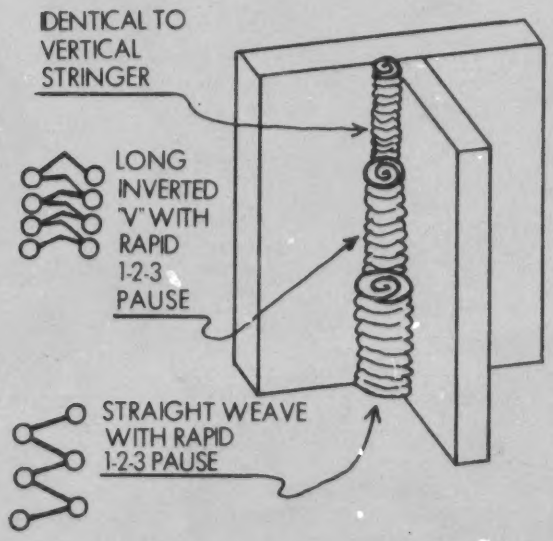
Instruction	Objectives	Teaching Suggest
o Fillet Welds; Vertical Position - Stringer bead - Padding - 3 pass - Multi pass	The student should be: Aware of the tendency to undercut when vertical welding.	Manipulative techniques weaving, and progressive should be introduced at Welding should be taught
o Stringer Beads; Overhead - Positioning stock - Manipulating the electrode - Running bead - Padding	Aware of the increased burn hazards in overhead welding. Acquainted with the increased difficulty of welding overhead.	Demonstrate rod angle ar and bead sequence.





	Objectives	Teaching Suggestions
tion	The student should be: Aware of the tendency to undercut when vertical welding.	Manipulative techniques —— whipping, weaving, and progressive rod angle —— should be introduced at this point. Welding should be taught "vertical-up."
Overhead ock he	Aware of the increased burn hazards in overhead welding. Acquainted with the increased difficulty of welding overhead.	Demonstrate rod angle and manipulation, and bead sequence.

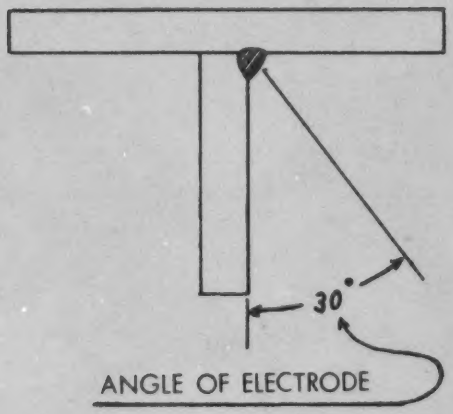


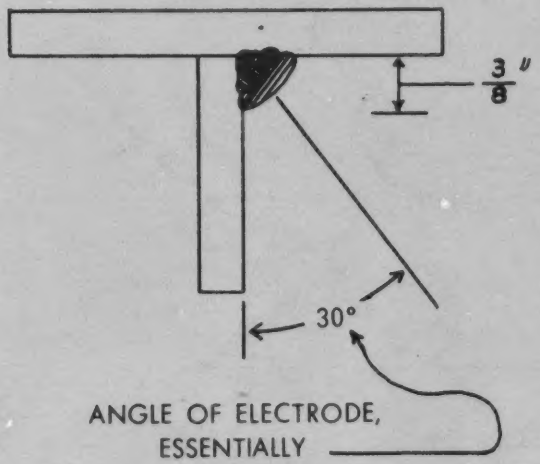


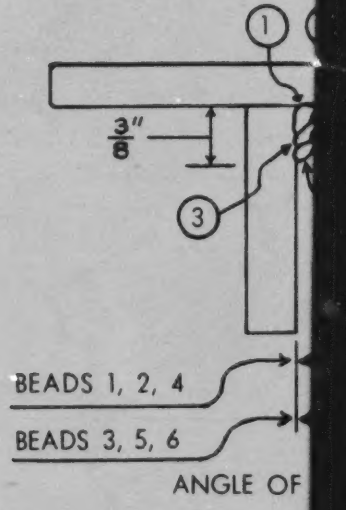
17

17A

Instruction	Objectives	Teaching Suggestio
o Fillet Welds; Overhead - Single pass - 3 pass - Multi pass	*The student should be able to:* Demonstrate an ability to adjust rod angle to meet varying conditions.	This process is the most the student to master.



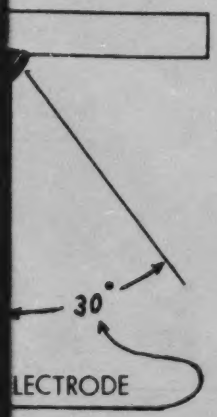


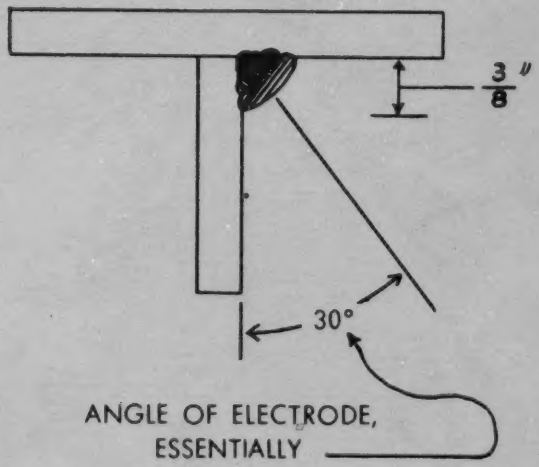


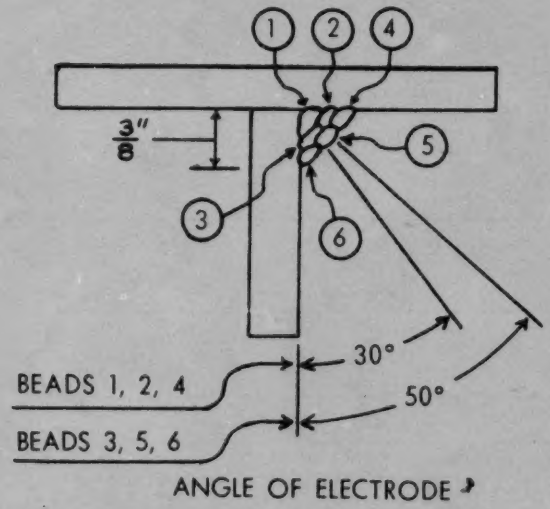
o Groove Weld; Overhead - 3 pass - Multi pass - Backing plate . With . Without 100 percent melt-through	*The student should be able to:* Demonstrate ability to weld a 100 percent melt-through, without slag inclusions, the inner and outer beads being uniformly smooth.	Teach "keyhole" technique penetration.

Objectives	Teaching Suggestions
Overhead	*The student should be able to:* Demonstrate an ability to adjust rod angle to meet varying conditions.

This process is the most difficult for the student to master.





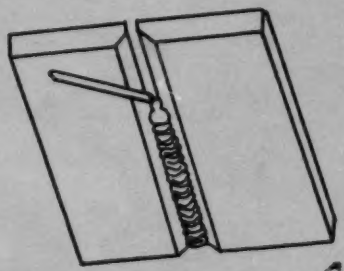


Overhead

Teach "keyhole" technique for root penetration.

t melt-

The student should be able to: Demonstrate ability to weld a 100 percent melt-through, without slag inclusions, the inner and outer beads being uniformly smooth.



18A

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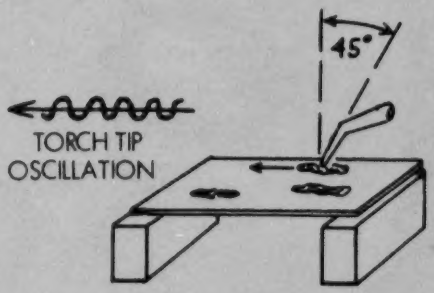
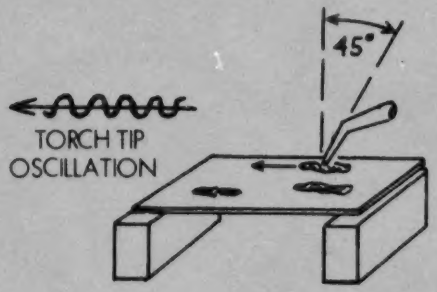
Instruction	Objectives	Teaching Suggest

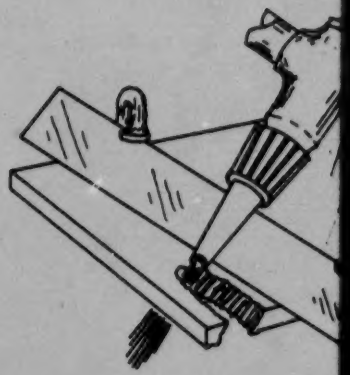
/Unit V — INTRODUCTION TO GAS WELDING

o Equipment - Nomenclature - Setting-up - Function - Properties of gases . Acetylene . Natural Gas . Propane - Flame adjustment - Rod classes	*The student should be able to:* Obtain without difficulty neutral, oxidizing, and carburizing flames. Demonstrate by any teacher-selected means an understanding of the nature, function, and uses of the three flames. Demonstrate by any teacher-selected means an ability to interpret AWS classification.	Note: Safety aspects mu Films are available to a the chemistry of fuel ga
o Operating the Oxyacetylene Torch; Flat Position - Techniques . Forehand . Backhand - Operations . Puddling (Flat plate) . Corner joint . Edge joint . Lap joint		Excellent films are avai commercial suppliers. Note: Forehand method s used on plate exc thickness.
o Using Filler Metal - Fillet joint - Lap joint - Butt joint - Multiple layer welds	Demonstrate entry-level co-ordination in two-handed pro-cedure. Hold filler rod at the correct angle in developing torch and puddle control.	Student should be aware build up filler metal 25 the thickness of the par Each layer must be well preceding layer at all p contact.

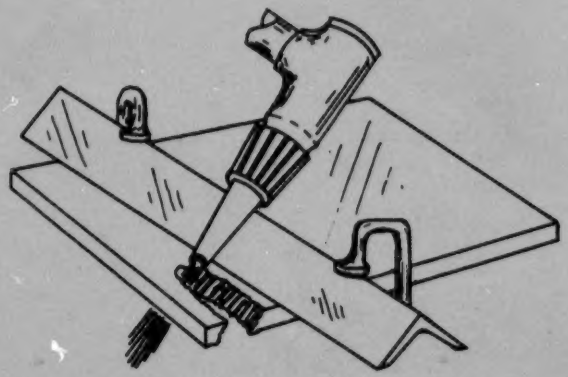
	Objectives	Teaching Suggestions
TRODUCTION TO GAS WELDING		
re	*The student should be able to:* Obtain without difficulty neutral, oxidizing, and carburizing flames.	Note: Safety aspects must be emphasized. Films are available to aid in understanding the chemistry of fuel gases.
of gases e Gas stment s	Demonstrate by any teacher-selected means an understanding of the nature, function, and uses of the three flames. Demonstrate by any teacher-selected means an ability to interpret AWS classification.	
he Oxyacetylene Position (Flat plate) oint t t		Excellent films are available from commercial suppliers. Note: Forehand method should not be used on plate exceeding 1/8-inch thickness.
Metal t	Demonstrate entry-level co-ordination in two-handed pro-cedure.	Student should be aware of the need to build up filler metal 25 percent above the thickness of the parent metal.
yer welds	Hold filler rod at the correct angle in developing torch and puddle control.	Each layer must be well fused to the preceding layer at all points of contact.

Instruction	Objectives	Teaching Suggestic
/Unit VI — **OXYACETYLENE WELDING PRACTICE**		
o Oxyacetylene Welding; All Positions - Puddling - Butt welds - Corners . Inside . Outside - Lap welds - Multiple layer welds . Groove . Fillet	*The student should be able to:* . Demonstrate the ability to control the molten puddle in all positions. Demonstrate an ability to weld plates of different thickness to field standards of quality.	Welding the joints should both with and without use metal. Both forehand and backhan should be practiced. Both visual and destructi be used.
o Operations - Running a bead - Butt welding . Light gage steel . Heavy gage steel - Fillet welding . Light gage steel . Heavy gage steel	Demonstrate ability to maintain beads of uniform width. Demonstrate ability to weld all common thicknesses of steel to field standards of quality.	The molten puddle should smooth in appearance. Excessive burn-through sh allowed. The height of overhead pl adjusted to be 12 inches student's head. Note: Check clothing fo before allowing t begin to weld ove

	Objectives	Teaching Suggestions
TYLENE WELDING PRACTICE		
lding;	*The student should be able to:* Demonstrate the ability to control the molten puddle in all positions.	Welding the joints should be practiced both with and without use of filler metal.
	Demonstrate an ability to weld plates of different thickness to field standards of quality.	Both forehand and backhand methods should be practiced.
welds		Both visual and destructive tests should be used.
	Demonstrate ability to maintain beads of uniform width.	The molten puddle should be clear and smooth in appearance.
teel teel		Excessive burn-through should not be allowed.
teel teel	Demonstrate ability to weld all common thicknesses of steel to field standards of quality.	The height of overhead plates should be adjusted to be 12 inches above the student's head.
		Note: Check clothing for fire-resistance before allowing the student to begin to weld overhead.

Instruction	Objectives	Teaching Suggest
/Unit VII — **CUTTING**	The student should be: Acquainted with the methods of cutting metals.	The student should be ma relative advantages of t mechanical methods of cu
o Methods - Arc - Oxyacetylene . Manual . Machine - Saw . Hand . Power	*The student should be able to:* Demonstrate an entry-level skill in all common cutting procedures.	
o Torch Cutting, Manual - Equipment . Nomenclature . Function . Safety - Cutting steel . Light gage plate . Heavy gage plate - Chamfering steel - Cutting rivets - Cutting cast iron - Cutting pipe - Gouging - Piercing	Demonstrate the ability to select, and set up the equipment needed to flame cut. Demonstrate the ability to cut all common metals in all standard forms, to field standards of quality.	 METHOD OF BEVELING PLA
o Torch Cutting, Machine - Machine set-up . Leveling track . Securing track - Speed adjustments - Direction of travel - Adjusting track and pinions . Torch position . Torch angle	Demonstrate the ability to set up, adjust, and operate a torch cutting-machine to field standards of quality and the capacity of the machine.	The student should be ma increased hazards in the

	Objectives	Teaching Suggestions
UTTING	The student should be: Acquainted with the methods of cutting metals.	The student should be made aware of the relative advantages of thermal and mechanical methods of cutting metals.
e	*The student should be able to:* Demonstrate an entry-level skill in all common cutting procedures.	
g, Manual ure el e plate e plate steel ets t iron	Demonstrate the ability to select, and set up the equipment needed to flame cut. Demonstrate the ability to cut all common metals in all standard forms, to field standards of quality.	
, Machine up rack rack ments travel ack and pinions tion e	Demonstrate the ability to set up, adjust, and operate a torch cutting-machine to field standards of quality and the capacity of the machine.	The student should be made aware of the increased hazards in the cutting process.



METHOD OF BEVELING PLATE—ACETYLENE

21A

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Instruction	Objectives	Teaching Suggestio
- Flame . Igniting . Adjusting - Torch tip . Removing . Cleaning	*The student should be able to:* Demonstrate ability to ignite and adjust the cutting flame. Demonstrate ability to remove, clean, and replace the torch tip.	The importance of flame a of maintaining a clean to be emphasized.
o Electrode Cutting - Equipment . Carbon arc . Metal electrode . Gouging electrode - Processes . Beveling . Piercing	Demonstrate the ability to select, set up, and operate to field standards, all equipment necessary to electrode-cut common materials.	Note: Helmet lens must b #12 to #14 for cut tion is *critical*.
o Power Sawing - Equipment . Type Hack Band . Accessories - Set-up - Cutting - Safety	The student should be: Acquainted with the function of power hacksaws and bandsaws, and the hazards inherent in their operation. Aware of the processes which each type saw can perform. *The student should be able to:* Demonstrate an ability to set-up and safely operate the power hacksaw for all common cuts. Prepare coupons for destructive testing.	The student should be abl adjust blades, but furthe is beyond the scope of th The student should be ca operating the bandsaw, i equipped with this optio

Objectives	Teaching Suggestions
The student should be able to: Demonstrate ability to ignite and adjust the cutting flame.	The importance of flame adjustment, and of maintaining a clean torch tip should be emphasized.
Demonstrate ability to remove, clean, and replace the torch tip.	
Demonstrate the ability to select, set up, and operate to field standards, all equipment necessary to electrode-cut common materials.	Note: Helmet lens must be changed from #12 to #14 for cutting. Ventilation is *critical*.
The student should be: Acquainted with the function of power hacksaws and bandsaws, and the hazards inherent in their operation.	The student should be able to change and adjust blades, but further maintenance is beyond the scope of this course.
Aware of the processes which each type saw can perform.	
The student should be able to: Demonstrate an ability to set-up and safely operate the power hacksaw for all common cuts.	The student should be capable of operating the bandsaw, if the shop is equipped with this optional machine.
Prepare coupons for destructive testing.	

Instruction	Objectives	Teaching Suggesti
/Unit VIII — **NONFUSION PROCESSES**		
o Braze Welding - Equipment . Nomenclature . Function - Fluxes . Function . Selection - Procedure; Flat Position . Lap joint . Butt joint . Groove joint . Fillet joint	The student should be: Aware of the fundamental difference between braze welding and brazing. Aware of the necessity of maintaining an even puddle. *The student should be able to:* Demonstrate the ability to interpret the color/temperature relationship effect on fluxing and brass flow.	Student should be made a different usage of the t *welding* and *brazing*. The teacher should selec conform to local usage o Emphasis should be place importance of achieving temperatures.
o Silver Soldering (Brazing) - Equipment - Fluxes - Procedure . Preparing the joint . Applying flux . Applying heat . Applying the metal Lap joint Butt joint Scarf joint	Demonstrate the ability to braze weld to acceptable field standards. Demonstrate ability to fit the basic joints to field standards of quality. Demonstrate the ability to run silver around pipe with 100 percent penetration. Demonstrate the ability to join stainless steel to field standards of quality.	The student must underst of fitting joints to 0.0 in attaining proper silv The student should be ca overheating stainless st Emphasize the need for w steel joints with hot wa soldering.
/Unit IX — **INERT GAS SHIELDED - ARC WELDING**		
o Equipment - Electrodes . Consumable . Nonconsumable	The student should be: Acquainted with the equipment and materials used in shielded-arc welding.	Films and pamphlets are several commercial suppl

	Objectives	Teaching Suggestions
IONFUSION PROCESSES		
g ure	The student should be: Aware of the fundamental difference between braze welding and brazing.	Student should be made aware of the different usage of the terms *braze welding* and *brazing*.
	Aware of the necessity of maintaining an even puddle.	The teacher should select visuals which conform to local usage of terms.
Flat Position int int	*The student should be able to:* Demonstrate the ability to interpret the color/temperature relationship effect on fluxing and brass flow.	Emphasis should be placed on the critical importance of achieving correct metal temperatures.
ring (Brazing)	Demonstrate the ability to braze weld to acceptable field standards.	
the joint flux eat he metal	Demonstrate ability to fit the basic joints to field standards of quality.	The student must understand the importance of fitting joints to 0.001-inch tolerance in attaining proper silver adherence.
t nt	Demonstrate the ability to run silver around pipe with 100 percent penetration.	The student should be cautioned against overheating stainless steel.
	Demonstrate the ability to join stainless steel to field standards of quality.	Emphasize the need for washing stainless steel joints with hot water after soldering.
T GAS SHIELDED - ARC WELDING		
ble	The student should be: Acquainted with the equipment and materials used in shielded-arc welding.	Films and pamphlets are available from several commercial suppliers.

Instruction	Objectives	Teaching Suggesti
- Shielding gases . Type . Function - Accessories . Rectifier . Power sources	The student should be: Aware of the function of the shielding gas and characteristics of each type. *The student should be able to:* Demonstrate by any teacher-selected means a basic knowledge of the nature, function, and characteristics of shielded-arc welding.	
o Process - Principles of operation . DC, Reverse Polarity . Electron and ion flow . Low and high density current . Transition current . DC, Standard Polarity . Melt-off rate . Filler-wire treatment . AC . Open circuit voltage . Pulse-arc . Arc stabilizing coatings . Power sources - Metal transfer . Globular . Spray	Demonstrate by any teacher-selected means an understanding of the manner in which the different currents affect the weld. Demonstrate an ability to select the current for any teacher-specified metal.	The teacher should demon effects of AC, DCSP, and
o Safety - Clothing - Shield lens - Grounding - Ventilation	Demonstrate by any teacher-specified means an awareness of the general and specific hazards in shielded-arc welding and of procedures designed to minimize them.	The National Safety Coun commercial suppliers pro films on welding safety.

	Objectives	Teaching Suggestions
es	The student should be: Aware of the function of the shielding gas and characteristics of each type.	
es	*The student should be able to:* Demonstrate by any teacher-selected means a basic knowledge of the nature, function, and characteristics of shielded-arc welding.	
operation Polarity ion flow density	Demonstrate by any teacher-selected means an understanding of the manner in which the different currents affect the weld.	
urrent Polarity e treatment voltage	Demonstrate an ability to select the current for any teacher-specified metal.	The teacher should demonstrate the effects of AC, DCSP, and DCRP.
ing coatings s		
	Demonstrate by any teacher-specified means an awareness of the general and specific hazards in shielded-arc welding and of procedures designed to minimize them.	The National Safety Council and some commercial suppliers provide excellent films on welding safety.

Instruction	Objectives	Teaching Suggest
/Unit X — **SHIELDED-ARC WELDING PRACTICE**		
o Tungsten Inert Gas (TIG) - Setting up equipment . Selecting the electrode - Setting current for different metals Heat AC or DC Polarity	*The student should be able to:* Demonstrate the ability to select the electrode and adjust the equipment for welding any teacher-selected joint and material.	Students should attain b in oxyacetylene before a
o Metallic Inert Gas (MIG) - Setting-up equipment . Setting current for different metals . Selecting shielding gas . Selecting filler metal	Demonstrate the ability to select the gas and filler rod, and adjust the equipment for all MIG procedures.	Generally, students find relatively easy to maste
o Procedures - Preparation	The student should be: Aware that joint preparation is the same as for arc and oxy welding of a given metal.	
- Positions . Butt . Lap . Fillet . Padding . Multi pass		Single pass welds should material of more than 1/ Multi-pass layers should 3/16-inch thickness.
- Materials . Aluminum . Magnesium . . Stainless steel	*The student should be able to:* Demonstrate an ability to TIG weld aluminum, magnesium, and stainless steel to field standards of quality.	TIG should be practiced mild steel, and stainles characteristics will app other common metals.

	Objectives	Teaching Suggestions
ED-ARC WELDING PRACTICE		
t Gas (TIG) quipment he electrode nt for tals	*The student should be able to:* Demonstrate the ability to select the electrode and adjust the equipment for welding any teacher-selected joint and material.	Students should attain basic competency in oxyacetylene before attempting TIG.
Gas (MIG) uipment rent for metals hielding gas iller metal	Demonstrate the ability to select the gas and filler rod, and adjust the equipment for all MIG procedures.	Generally, students find MIG techniques relatively easy to master.
	The student should be: Aware that joint preparation is the same as for arc and oxy welding of a given metal.	
		Single pass welds should not be used on material of more than 1/4-inch thickness.
		Multi-pass layers should be restricted to 3/16-inch thickness.
eel	*The student should be able to:* Demonstrate an ability to TIG weld aluminum, magnesium, and stainless steel to field standards of quality.	TIG should be practiced on aluminum, mild steel, and stainless steel, since the characteristics will approximate those of other common metals.

Instruction	Objectives	Teaching Suggesti
	The student should be able to: Demonstrate ability to MIG weld to field standards of quality.	
- Testing . In process . Post weld	Demonstrate by any teacher-selected means an ability to recognize defective welding, and diagnose and correct the cause.	Demonstrate and discuss s as poor joint fit-up or t excessive weaving or erra dirty wire or base metal, supply of shielding gas, or voltage.
/Unit XI — **WELDING CAST IRON**		
o Nature and Properties of Cast Iron - Expansion characteristics - Type of metal - Recognition	Demonstrate sufficient knowledge of cast iron metallurgy to select the most effective methods and procedures.	Properties of cast iron s only as they affect weldi
	Demonstrate an ability to recognize cast iron.	The use of the spark test taught.
o Arc Welding of Cast Iron - Metal preparation . Preheating . Postheating . Controlled cooling - Electrode selection . Machinable . Nonmachinable - Process . Bead length . Peening	Demonstrate an ability to select and adjust equipment, prepare the metal, and weld cast iron to field standards of quality by both arc and oxy processes.	Sequence of welds is of v when welding cast iron ob size or mass.
o Oxyacetylene Welding of Cast Iron - Metal preparation - Equipment selection		Metal preparation is mor welding than in arc weldi control of the metal bef after welding is extreme

	Objectives	Teaching Suggestions
	The student should be able to: Demonstrate ability to MIG weld to field standards of quality.	
	Demonstrate by any teacher-selected means an ability to recognize defective welding, and diagnose and correct the cause.	Demonstrate and discuss such common faults as poor joint fit-up or torch angle, excessive weaving or erratic wire feed, dirty wire or base metal, inadequate supply of shielding gas, and low current or voltage.
IG CAST IRON		
perties	Demonstrate sufficient knowledge of cast iron metallurgy to select the most effective methods and procedures.	Properties of cast iron should be taught only as they affect welding.
racteristics		
	Demonstrate an ability to recognize cast iron.	The use of the spark test should be taught.
Cast Iron ion	Demonstrate an ability to select and adjust equipment, prepare the metal, and weld cast iron to field standards of quality by both arc and oxy processes.	Sequence of welds is of vital importance when welding cast iron objects of large size or mass.
ooling ction		
e		
lding		Metal preparation is more critical in oxy welding than in arc welding. Temperature control of the metal before, during, and after welding is extremely important.
ion ction		

Instruction	Objectives	Teaching Suggest
. Torch tip . Rod . Flux - Process . Flame adjustment . Oxide removal		Note: Flame MUST be neu be used as a pudd
o Brazing of Cast Iron - Equipment selection . Tip . Rod . Flux - Metal preparation - Process . Flame adjustment . Rod application	*The student should be able to:* Demonstrate an ability to braze cast iron to field standards of quality.	Note: Brazing requires cast iron surface Preheating and po critical importan

/Unit XII — WELDING STAINLESS STEEL

o Arc Welding - Selecting rod - Preparation . Spatter proofing - Current setting . Polarity . Power	Demonstrate ability to select and set up arc equipment for welding stainless steels.	Teacher should use 16-ga teaching sheet metal wel Spatter prevention is ne Rod size and current set
- Identifying metal group . Martensitic . Austenitic	Demonstrate the ability to classify by group, samples provided by the teacher, and to adapt welding techniques to the samples' characteristics.	

	Objectives	Teaching Suggestions
		Note: Flame MUST be neutral. Rod may be used as a puddling stick.
tment al		
t Iron ection	*The student should be able to:* Demonstrate an ability to braze cast iron to field standards of quality.	Note: Brazing requires exposure of pure cast iron surfaces. Preheating and postheating are of critical importance.
tion		
tment tion		
NG STAINLESS STEEL		
	Demonstrate ability to select and set up arc equipment for welding stainless steels.	Teacher should use 16-ga. metal in teaching sheet metal welding.
fing g		Spatter prevention is necessary.
		Rod size and current setting are critical.
tal group	Demonstrate the ability to classify by group, samples provided by the teacher, and to adapt welding techniques to the samples' characteristics.	

Instruction	Objectives	Teaching Suggesti
	The student should be able to:	
- Procedure . Stringer bead . Butt Squared Flanged Beveled . Lap . Corner	Demonstrate the ability to weld stainless steels to field standards of quality.	Note: Arc welding of lig steel should be ma student progresses steel. Procedures those used to weld DCSP power is used
/Unit XIII — **PIPE WELDING**		
o Preparation . Marking . Wrap-arounds . Contour markers	The student should be: Acquainted with the common aids to locating cuts and welds.	Pipe welding is considere difficult process a welde
- Beveling . Hand Maintaining angle . Machine . Tip maintenance	Acquainted with accepted procedure in beveling edges. Aware of the importance of slag removal, pipe alignment, and adherence to tacking sequence.	Films on pipe welding are several commercial suppli
- Slag removal - Pipe alignment . Tacking sequence		
o Execution - Pipe setting . Roll . Fixed	*The student should be able to:* Demonstrate ability to set up welding machines for pipe welding.	
- Pipe axis . Horizontal . Vertical	Demonstrate proper procedure in manual welding of pipe.	Since only extensive pra trade competency in pipe student should ordinaril correctness of procedure quality of weld.

Objectives	Teaching Suggestions
The student should be able to: Demonstrate the ability to weld stainless steels to field standards of quality.	Note: Arc welding of light gage mild steel should be mastered before the student progresses to stainless steel. Procedures are similar to those used to weld aluminum except DCSP power is used.
The student should be: Acquainted with the common aids to locating cuts and welds.	Pipe welding is considered to be the most difficult process a welder must master.
Acquainted with accepted procedure in beveling edges.	
Aware of the importance of slag removal, pipe alignment, and adherence to tacking sequence.	Films on pipe welding are available from several commercial suppliers.
The student should be able to: Demonstrate ability to set up welding machines for pipe welding.	
Demonstrate proper procedure in manual welding of pipe.	Since only extensive practice can produce trade competency in pipe welding, the student should ordinarily be graded on correctness of procedure rather than quality of weld.

Instruction	Objectives	Teaching Suggesti
- Machine settings - Rod angle - Maintaining keyhole . 100 percent melt through - Beat sequence		Note: Joint fit-up may b course if local jo require. Templates for joint fit-u from commercial sources.
/Unit XIV — **PLASMA WELDING (OPTIONAL UNIT)**		
o Process - Torch types . Transferred . Nontransferred	The student should be: Acquainted with plasma welding equipment.	The teacher should demons and the effect of both to
- Gases	The student should be: Acquainted with the nature of the process.	Excellent films are avail commercial supplier.
- Temperature range . 6000°F. . 100,000°F.	Aware of the relationship between frequency and resulting temperature.	Opaque projection of phot craft ground crews, and c target shooters wearing h should have motivational libraries maintain files some of which (The Americ June 1969, p.25) contain explaining in layman's te cumulative effects of hig
- Safety . Eye . Skin . Ear	Aware of the need to protect against hearing loss, as well as against burns and eye injuries.	

Objectives	Teaching Suggestions
ings	Note: Joint fit-up may be added to the course if local job opportunities require.
keyhole t melt through e	Templates for joint fit-up are available from commercial sources.
SMA WELDING (OPTIONAL UNIT)	
The student should be: Acquainted with plasma welding equipment.	The teacher should demonstrate the use and the effect of both torches.
rred	
The student should be: Acquainted with the nature of the process.	Excellent films are available from a commercial supplier.
ange Aware of the relationship between frequency and resulting temperature.	Opaque projection of photos of jet aircraft ground crews, and of claybird and target shooters wearing hearing protectors should have motivational value. Most libraries maintain files of periodicals, some of which (The American Rifleman, June 1969, p.25) contain articles explaining in layman's terms, the cumulative effects of high-level noise.
Aware of the need to protect against hearing loss, as well as against burns and eye injuries.	

Instruction	Objectives	Teaching Suggest
- Base metals . Stainless steels . Nickel . Copper . Aluminum . Magnesium . Dissimilar metals	*The student should be able to:* Demonstrate by any teacher-selected means the ability to select equipment and gas, and to set controls for any specific plasma welding operation.	
o Fusion - Selecting equipment - Setting controls	Demonstrate the ability to plasma fuse to field standards of appearance and strength.	Plasma welding is becomi in certain industries, b sufficiently widespread clusion in this syllabus content. It is presente content for use where em tions warrant.
o Cutting - Selecting the torch - Setting the controls	Demonstrate an ability to set current and adjust gas flow as necessary to cut to field standards of quality.	

	Objectives	Teaching Suggestions
steels	*The student should be able to:* Demonstrate by any teacher-selected means the ability to select equipment and gas, and to set controls for any specific plasma welding operation.	
metals		
ipment ols	Demonstrate the ability to plasma fuse to field standards of appearance and strength.	Plasma welding is becoming more important in certain industries, but as yet is not sufficiently widespread to justify inclusion in this syllabus as required content. It is presented as optional content for use where employment conditions warrant.
torch ontrols	Demonstrate an ability to set current and adjust gas flow as necessary to cut to field standards of quality.	

BOOKS

Althouse, A. D., Turnquist, C. H. & Bowditch, W. A. *Modern welding.* Homewood, Ill. Goodheart-Wi

American Welding Society. *Welding handbook.* 6th ed. New York. The Society. 1968.

Bennett, A. E. & Siy, L. J. *Blueprint reading for welders.* Albany, N.Y. Delmar Publishers, Inc.

Compressed Gas Association. *Regulations for manifolding and piping oxygen and acetylene.* New Yo
The Association.

_____ *Regulations for safe handling of acetylene.* New York. The Association.

Delmar Publishers, Inc. *Templet development for the pipe trades.* Albany, N.Y. The Corporation.

Department of the Navy. *Shipfitters series.* Washington. U.S. Government Printing Office. 1965

Giachino, J. W., Weeks, W. & Johnson, G. S. *Welding technology.* Chicago. American Technical So

Graham, F. D. *Welders guide.* Indianapolis. Theodore Audel & Co. 1968.

Griffin, I. H. & Roden, E. M. *Basic arc welding.* rev. ed. Albany, N.Y. Delmar Publishers, Inc

_____ *Basic oxyacetylene welding.* Albany, N.Y. Delmar Publishers, Inc. 1967 edition.

_____ *Basic TIG welding.* Albany, N.Y. Delmar Publishers, Inc. 1962.

_____ *Pipe welding techniques.* Albany, N.Y. Delmar Publishers, Inc. 1964.

Hiller Electric Company. *Welding processes and power sources.* Appleton, Wis. The Company. 196

Hobart Trade School. *Micro wire welding.* Troy, Ohio. The School. 1942.

_____ *Practical arc welding.* Troy, Ohio. The School.

_____ *Programmed instruction for welding symbols.* 4th ed. Troy, Ohio. The School.

Jefferson, T. B. & Woods, G. *Metals and how to weld them.* 2nd ed. Cleveland. Lincoln Electric

Lincoln Electric Company. *New lessons in arc welding.* Cleveland. The Company. 1957.

_____ *Procedure handbook of arc welding.* 11th ed. Cleveland. The Company. 1970.

Linde Division. *Oxy-acetylene handbook.* New York. Union Carbide Corporation.

Sacks, R. J. *Theory and practice of arc welding.* 2nd ed. Princeton, N.J. D. Van Nostrand Co.

Smith Welding Equipment Division. *Flame cutting facts.* Minneapolis. The Tescom Corporation. 1

U.S. Office of Education. *Occupational information and training requirements in the field of wel*
Washington. U.S. Government Printing Office.

RESOURCES

urnquist, C. H. & Bowditch, W. A. *Modern welding.* Homewood, Ill. Goodheart-Willcox Co. 1967.

ociety. *Welding handbook.* 6th ed. New York. The Society. 1968.

iy, L. J. *Blueprint reading for welders.* Albany, N.Y. Delmar Publishers, Inc. 1968 edition.

ociation. *Regulations for manifolding and piping oxygen and acetylene.* New York.

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Navy. *Shipfitters series.* Washington. U.S. Government Printing Office. 1965.

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ders guide. Indianapolis. Theodore Audel & Co. 1968.

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lding. Albany, N.Y. Delmar Publishers, Inc. 1962.

techniques. Albany, N.Y. Delmar Publishers, Inc. 1964.

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Woods, G. *Metals and how to weld them.* 2nd ed. Cleveland. Lincoln Electric Company. 1969.

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. Government Printing Office.

31A

FILMS —— 16 mm., Sound

Air Reduction Sales		
Structural Welding	15 min.	color
Aluminum Company of America		
A Product of Imagination	26 min.	color
How to Weld Aluminum —— Torch	17 min.	b&w
How to Weld Aluminum —— MIG	20 min.	color
The Story of Aluminum	20 min.	color
Welding Advances with Aluminum	28 min.	color
American Society for Metals		
Heat Treatment of Steels	30 min.	color
How Metals Behave	30 min.	color
Iron Carbon Alloys	30 min.	color
Metal Crystals	30 min.	color
Armco		
Iron Ore From Labrador	18 min.	color
Associated Film Service		
These People Know the Steel Business	30 min.	color
Bethlehem Steel Corporation		
The Toughest Inch	28 min.	color
Eutectic Welding Alloys, Inc.		
This Is Eutalloy	20 min.	color
Lincoln Electric Company		
Design of Arc Welded Structures	15 min.	color
Designing Machinery for Arc Welding	15 min.	color
Flame Cutting	20 min.	color
Magic Wand of Industry —— Arc Welding	20 min.	color
Prevention and Control of Distortion in Arc Welding	20 min.	color

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Linde Division, Union Carbide Corporation		
Braze Welding	12 min.	color
Modern Talking Pictures Service		
Metallurgy Plus	14 min.	color
Story of Stainless Steel	27 min.	color
This Is Steel	29 min.	color
Zinc Controls Corrosion	38 min.	color
Reynolds Metals Company		
Aluminum On The March	24 min.	color
Aluminum Pipelines	28 min.	color
Aluminum Welding	33 min.	color
Rothacker Incorporated		
Mining for Nickel	45 min.	color
Milling and Smelting the Sudbury Ores	54 min.	color
Refining Nickel from Sudbury Ores	52 min.	color
Refining Copper from Sudbury Ores	39 min.	color
Refining Precious Metals	29 min.	color
U.S. Bureau of Mines		
How to Weld Aluminum	17 min.	color
Oxyacetylene, Flame-Master of Metals	19 min.	color
Story of Arc Welding	24 min.	color
United States Steel Corporation		
Hot Rolling of Steel Sheets	7 min.	color
Modern Steel Making	23 min.	color
Open Hearth Furnace	7 min.	color
Research in Steel	26 min.	color
Walls without Welds	28 min.	color

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33A

CHARTS

Hobart Brothers Training Aids

AC/DC Transformer Rectifier Arc Welder
Types of Welds
Typical Welded Joints
Welding Positions

DEMONSTRATION AIDS

Hobart Brothers Training Aids

Filter plastic panel screen, density #10
Folding welding booth
Plastic sample welds
Plastic welds —— good, and defective. Set of 10

TRANSPARENCIES

DCA Educational Products

Arc Welding. Series of 53 multicolored transparencies, with overlays.

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Mobart Brothers Training Aids

AC/DC Transformer Rectifier Arc Welder
Types of Welds
Typical Welded Joints
Welding Positions

STRATION AIDS

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Folding welding booth
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Plastic welds —— good, and defective. Set of 10

PARENCIES

CA Educational Products

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TEACHING AID SOURCES

Air Reduction Sales
P.O. Box 2
Union, New Jersey 02083

Aluminum Company of America
1501 Alcoa Building
Mellon Square
Pittsburgh, Pennsylvania 15219

American Society for Metals
Film Programs, Inc.
2238 Euclid Avenue
Cleveland, Ohio 44115

American Technical Society
848 E. 58th Street
Chicago, Illinois 60637

American Welding Society
345 E. 47th Street
New York, New York 10017

Armco Film Library
703 Curtis Street
Middletown, Ohio 45042

Associated Film Service
660 Grand Avenue
Ridgefield, New Jersey 07657

Bethlehem Steel Corporation
Advertising Division
Bethlehem, Pennsylvania 18016

Compressed Gas Association
11 W. 42nd Street
New York, New York 10017

DCA Educational Products, Inc.
4865 Stenton Avenue
Philadelphia, Pennsylvania 191

D. Van Nostrand Company
24 W. 40th Street
New York, New York 10018

Delmar Publishers Division
Mountainview Avenue
Albany, New York 12205

Edward R. Pierre c/o
Hiller Electric Company
Appleton, Wisconsin 54911

Eutectic Welding Alloys, Inc.
40-40 172 Second Street
Flushing, New York 11368

Goodheart-Willcox Co., Inc.
18250 Harwood Avenue
Homewood, Illinois 60430

Hobart Trade School
Box EW-157
Troy, Ohio 45373

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.O. Box 2
nion, New Jersey 02083

luminum Company of America
501 Alcoa Building
ellon Square
ittsburgh, Pennsylvania 15219

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ilm Programs, Inc.
238 Euclid Avenue
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nerican Technical Society
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Coit Road
Cleveland, Ohio 44117

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Union Carbide Corporation
270 Park Avenue
New York, New York 10017

Power Publications Company
P.O. Box 96
Appleton, Wisconsin 54911

Modern Talking Pictures Service
1212 Avenue of the Americas
New York, New York 10036

Reynolds Aluminum Company
Motion Picture Department
P.O. Box 2346
6603 W. Broad Street
Richmond, Virginia 23218

Rothacker Incorporated
241 W. 17th Street
New York, New York 10011

Smith Welding Equipment
Division of Tescom Corporation
2633 S.E. Fourth Street
Minneapolis, Minnesota 55414

Superintendent of Documents
U.S. Government Printing Offic
Washington, D.C. 20402

Theodore Audel & Company Divis
H. W. Sams & Company, Inc.
4300 W. 42nd Street
Indianapolis, Indiana 46206

U.S. Atomic Energy Commission
376 Hudson Street
New York, New York 10014

U.S. Bureau of Mines
Department of the Interior —
Motion Pictures
4800 Forbes Avenue
Pittsburgh, Pennsylvania 1521

United States Steel Corporatio
New York Film Distribution Cen
71 Broadway
New York, New York 10006

Westinghouse Film Library
713 Penn Avenue
Pittsburgh, Pennsylvania 1522

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Lincoln Electric Company
Coit Road
Cleveland, Ohio 44117

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Westinghouse Film Library
713 Penn Avenue
Pittsburgh, Pennsylvania 15221

SUGGESTED MINIMUM EQUIPMENT

The listing does not include those desirable items which can be fabricated in the welding shop conjunction with the school machine shop, nor those needed for the more sophisticated welding items listed under PERSONAL require one per student; those under STATION, one per welding stat under GENERAL, one for each class unit of 15 students. The number and type of items of genera must conform to legal specifications when so regulated, or be selected with regard to the spec situation.

PERSONAL	STATION	GENE
	ARC WELDING	
Apron	Arc welding machine	
Gloves	Motor generator, DC	
Goggles, flash	Transformer, AC	
Goggles, safety	Rectifier, AC-DC	
Helmet	Electrode cable	
Shoes, safety	Electrode holder	
Sleeves	Ground cable	
	Ground clamp	
	Terminal lugs (2)	
	Hammer, chipping	
	Brush, wire	
	OXYACETYLENE WELDING	
Gloves, asbestos	Tank, acetylene	Cutting machi
Goggles, welding	Tank, oxygen	Attachment, c
Hand shield	Hose, acetylene	
Leather cape	Hose, oxygen	
	Cart, gas bottle	
	Regulator set, double or single stage	
	Torch, welding, with tips	
	Torch, cutting, with tips	
	Lighter	
	Tip cleaner	

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SUGGESTED MINIMUM EQUIPMENT

pes not include those desirable items which can be fabricated in the welding shop alone or in ith the school machine shop, nor those needed for the more sophisticated welding systems. The nder PERSONAL require one per student; those under STATION, one per welding station; those one for each class unit of 15 students. The number and type of items of general equipment o legal specifications when so regulated, or be selected with regard to the specific teaching

STATION	GENERAL
ARC WELDING	
Arc welding machine	
Motor generator, DC	
Transformer, AC	
Rectifier, AC-DC	
Electrode cable	
Electrode holder	
Ground cable	
Ground clamp	
Terminal lugs (2)	
Hammer, chipping	
Brush, wire	
OXYACETYLENE WELDING	
Tank, acetylene	Cutting machine
Tank, oxygen	Attachment, circular cutting
Hose, acetylene	
Hose, oxygen	
Cart, gas bottle	
Regulator set, double or single stage	
Torch, welding, with tips	
Torch, cutting, with tips	
Lighter	
Tip cleaner	

WELDING SHOP GENERAL EQUIPMENT

HAND TOOLS

Caliper; inside, 8 in.
Caliper; outside, 8 in.
Centerpunch; set
Chalkline
Chisel; cold, 1/2, 5/8, 3/4
Files; assorted
Hacksaw
Hammer; ball pein, 24 oz., 16 oz.
Hammer; sledge, 4 lb.
Pipecutter; wheel type, 4 in. capacity
Pipe reamer
Pliers; vise-grip
Pliers; lineman's, 8 in.
Pliers; needlenose, 6 in.
Pliers; slip-joint, 8 in., 10 in.
Plumb bob
Punch; drift, 5/16, 7/16
Punch; pin, 5/16
Rule; circumference
Screwdriver; Phillips, set, #0 to #4
Screwdriver; standard, set, 3/16 x 4
Spirit level; aluminum, 24 in.
Spirit level; aluminum, torpedo
Square; combination, with centerhead
Square; framing
Tape measure; 8 ft., 12 ft., 50 ft.
Tap and die; set, 1/4 to 1/2 by 16th
  combination coarse and fine
Tongs; 24 in.
Twist drill; set, 1/16 to 1/2 by 16t
Wing dividers; 6 in., 8 in.
Wrench; Allen, set
Wrench; combination box and open end
  5/16 to 1 1/8
Wrench; crescent, 6 in., 8 in., 12 i
Wrench; pipe, 8 in., 12 in., 18 in.
Wrench; socket, set, 3/8 to 7/8, 3/8
  drive with extensions

MACHINES

Drill press; floor mount, tilting
  T-slot table with vise, 450 rpm
  maximum slow speed, w/accessories
Portable drill; 3/8 in. capacity
Portable drill; 1/2 in. capacity
Power grinder; pedestal, 12 in. minimum
Power grinder; portable, 7 in.
Power hacksaw
Testing machine; hydraulic
Bandsaw (optional)

OTHER

Anvil
Bench; layout
Blanket; fire
Booth; welding
Clamp; bar
Clamp; C
Clamp; welding
Dresser; grinding wheel
Extinguishers; Type A and Type B/C
Screens; portable
Solder kits
Stones; marking
Tanks; quenching
Ventilating system
Vise; bench, machinists

WELDING SHOP GENERAL EQUIPMENT

HAND TOOLS

liper; inside, 8 in.
liper; outside, 8 in.
terpunch; set
lkline
sel; cold, 1/2, 5/8, 3/4
es; assorted
ksaw
mer; ball pein, 24 oz., 16 oz.
mer; sledge, 4 lb.
ecutter; wheel type, 4 in. capacity
e reamer
ers; vise-grip
ers; lineman's, 8 in.
ers; needlenose, 6 in.
ers; slip-joint, 8 in., 10 in.
mb bob
ch; drift, 5/16, 7/16
ch; pin, 5/16
Rule; circumference
Screwdriver; Phillips, set, #0 to #4
Screwdriver; standard, set, 3/16 x 4 to 3/8 x 15
Spirit level; aluminum, 24 in.
Spirit level; aluminum, torpedo
Square; combination, with centerhead
Square; framing
Tape measure: 8 ft., 12 ft., 50 ft.
Tap and die; set, 1/4 to 1/2 by 16ths, combination coarse and fine
Tongs; 24 in.
Twist drill; set, 1/16 to 1/2 by 16ths
Wing dividers; 6 in., 8 in.
Wrench; Allen, set
Wrench; combination box and open end, 5/16 to 1 1/8
Wrench; crescent, 6 in., 8 in., 12 in.
Wrench; pipe, 8 in., 12 in., 18 in.
Wrench; socket, set, 3/8 to 7/8, 3/8 in. drive with extensions

MACHINES

l1 press; floor mount, tilting
-slot table with vise, 450 rpm
ximum slow speed, w/accessories
table drill; 3/8 in. capacity
table drill; 1/2 in. capacity
r grinder; pedestal, 12 in. minimum
r grinder; portable, 7 in.
r hacksaw
ting machine; hydraulic
lsaw (optional)

OTHER

Anvil
Bench; layout
Blanket; fire
Booth; welding
Clamp; bar
Clamp; C
Clamp; welding
Dresser; grinding wheel
Extinguishers; Type A and Type B/C
Screens; portable
Solder kits
Stones; marking
Tanks; quenching
Ventilating system
Vise; bench, machinists

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EYE SAFETY

These excerpts from the *Z87.1-1968 USA Standard Practices for Occupational and Educational E Protection* relate to the use of eye safety devices. This information represents factors for scho consider in the acquisition and maintenance of eye protective devices. The remainder of the Bull tion about technical testing and production standards.

Selection Chart

Recommended Eye and Face Protectors for Use in Industry, Schools, and Colleges

1. **GOGGLES,** Flexible Fitting, Regular Ventilation
2. **GOGGLES,** Flexible Fitting, Hooded Ventilation
3. **GOGGLES,** Cushioned Fitting, Rigid Body
*4. **SPECTACLES,** Metal Frame, with Sideshields
*5. **SPECTACLES,** Plastic Frame, with Sideshields
*6. **SPECTACLES,** Metal-Plastic Frame, with Sideshields
** 7. **WELDING GOGGLES,** Eyecup Type, Tinted Lenses (Illustrated)
7A. **CHIPPING GOGGLES,** Eyecup Type, Clear Safety Lenses (Not Illustrated)
** 8. **WELDING GOGGLES,** Coverspec Type Tinted Lenses (Illustrated)
8A. **CHIPPING GOGGLES,** Coverspec Type, Clear Safety Lenses (Not Illustrated)
** 9. **WELDING GOGGLES,** Coverspec Type, Tinted Plate Lens
10. **FACE SHIELD** (Available with Plastic or Mesh Window)
11. **WELDING HELMETS

*Non-sideshield spectacles are available for limited hazard use requiring only frontal protection.
**See appendix chart "Selection of Shade Numbers for Welding Filters."

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EYE SAFETY

from the *Z87.1-1968 USA Standard Practices for Occupational and Educational Eye and Face* o the use of eye safety devices. This information represents factors for school districts to uisition and maintenance of eye protective devices. The remainder of the Bulletin is informa- l testing and production standards.

Selection Chart

Recommended Eye and Face Protectors for Use in Industry, Schools, and Colleges

1. **GOGGLES,** Flexible Fitting, Regular Ventilation
2. **GOGGLES,** Flexible Fitting, Hooded Ventilation
3. **GOGGLES,** Cushioned Fitting, Rigid Body
4. **SPECTACLES,** Metal Frame, with Sideshields
5. **SPECTACLES,** Plastic Frame, with Sideshields
6. **SPECTACLES,** Metal-Plastic Frame, with Sideshields

** 7. **WELDING GOGGLES,** Eyecup Type, Tinted Lenses (Illustrated)
7A. **CHIPPING GOGGLES,** Eyecup Type, Clear Safety Lenses (Not Illustrated)
** 8. **WELDING GOGGLES,** Coverspec Type Tinted Lenses (Illustrated)
8A. **CHIPPING GOGGLES,** Coverspec Type, Clear Safety Lenses (Not Illustrated)
** 9. **WELDING GOGGLES,** Coverspec Type, Tinted Plate Lens
10. **FACE SHIELD** (Available with Plastic or Mesh Window)
11. **WELDING HELMETS

*Non-sideshield spectacles are available for limited hazard use requiring only frontal protection.
**See appendix chart "Selection of Shade Numbers for Welding Filters."

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APPLICATIONS		
Operation	Hazards	Recommended Protectors: Bold Type Numbers Signify Protection
ACETYLENE-BURNING ACETYLENE-CUTTING ACETYLENE-WELDING	SPARKS, HARMFUL RAYS, MOLTEN METAL, FLYING PARTICLES	**7**,**8**,**9**
CHEMICAL HANDLING	SPLASH, ACID BURNS, FUMES	**2**,10 (For severe exposure add 10 over 2)
CHIPPING	FLYING PARTICLES	**1**,**3**,4,5,6,**7**A,**8**A
ELECTRIC (ARC) WELDING	SPARKS, INTENSE RAYS, MOLTEN METAL	9,**11** (11 in combination with 4,5,6, in t advisable)
FURNACE OPERATIONS	GLARE, HEAT, MOLTEN METAL	**7**,**8**,**9** (For severe exposure add **10**)
GRINDING-LIGHT	FLYING PARTICLES	**1**,**3**,**4**,**5**,**6**,10
GRINDING-HEAVY	FLYING PARTICLES	**1**,**3**,**7**A,**8**A (For severe exposure add **10**)
LABORATORY	CHEMICAL SPLASH, GLASS BREAKAGE	**2** (10 when in combination with **4**,**5**,**6**)
MACHINING	FLYING PARTICLES	**1**,**3**,**4**,**5**,**6**,10
MOLTEN METALS	HEAT, GLARE, SPARKS, SPLASH	**7**,**8** (**10** in combination with **4**,**5**,**6**, in ti
SPOT WELDING	FLYING PARTICLES, SPARKS	**1**,**3**,**4**,**5**,**6**,10

APPLICATIONS		
	Hazards	Recommended Protectors: Bold Type Numbers Signify Preferred Protection
NG NG NG	SPARKS, HARMFUL RAYS, MOLTEN METAL, FLYING PARTICLES	**7**,**8**,**9**
NG	SPLASH, ACID BURNS, FUMES	**2**,10 (For severe exposure add 10 over 2)
	FLYING PARTICLES	**1**,**3**,4,5,6,**7**A,**8**A
ELDING	SPARKS, INTENSE RAYS, MOLTEN METAL	9,**11** (11 in combination with 4,5,6, in tinted lenses, advisable)
NS	GLARE, HEAT, MOLTEN METAL	**7**,**8**,**9** (For severe exposure add **10**)
	FLYING PARTICLES	**1**,**3**,**4**,**5**,**6**,10
	FLYING PARTICLES	**1**,**3**,**7**A,**8**A (For severe exposure add **10**)
	CHEMICAL SPLASH, GLASS BREAKAGE	**2** (10 when in combination with **4**,**5**,**6**)
	FLYING PARTICLES	**1**,**3**,**4**,**5**,**6**,10
	HEAT, GLARE, SPARKS, SPLASH	**7**,**8** (**10** in combination witn **4**,**5**,**6**, in tinted lenses)
. .	FLYING PARTICLES, SPARKS	**1**,**3**,**4**,**5**,**6**,10

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Selection of Shade Numbers for Welding Filters

The following is a guide for the selection of the proper shade numbers of filter lenses or p
welding. Shades more dense than those shown for various operations may be selected to suit the i

Welding Operation	Suggeste
Shielded metal-arc welding; 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes	
Gas-shielded arc welding (nonferrous) 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes	
Gas-shielded arc welding (ferrous) 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes	
Shielded metal-arc welding 3/16-, 7/32-, 1/4-inch diameter electrodes	
5/16-, 3/8-inch diameter electrodes	
Atomic hydrogen welding	
Carbon-arc welding	
Soldering	
Torch brazing	3
Light cutting, up to 1 inch	3
Medium cutting, 1 inch to 6 inches	4
Heavy cutting, over 6 inches	5
Gas welding (light), up to 1/8 inch	4
Gas welding (medium), 1/8 inch to 1/2 inch	5
Gas welding (heavy), over 1/2 inch	6

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Selection of Shade Numbers for Welding Filters

; is a guide for the selection of the proper shade numbers of filter lenses or plates used in
ore dense than those shown for various operations may be selected to suit the individual's needs.

Welding Operation	Suggested Shade Number
ed metal-arc welding; -, 3/32-, 1/8-, 5/32-inch diameter electrodes	10
ielded arc welding (nonferrous) -, 3/32-, 1/8-, 5/32-inch diameter electrodes	11
ielded arc welding (ferrous) -, 3/32-, 1/8-, 5/32-inch diameter electrodes	12
ed metal-arc welding -, 7/32-, 1/4-inch diameter electrodes	12
-, 3/8-inch diameter electrodes	14
hydrogen welding	10-14
-arc welding	14
ing	2
brazing	3 or 4
cutting, up to 1 inch	3 or 4
cutting, 1 inch to 6 inches	4 or 5
cutting, over 6 inches	5 or 6
lding (light), up to 1/8 inch	4 or 5
lding (medium), 1/8 inch to 1/2 inch	5 or 6
lding (heavy), over 1/2 inch	6 or 8

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6.4 MAINTENANCE AND DISINFECTION OF EYE PROTECTORS

6.4.1 Maintenance

6.4.1.1 It is essential that the lenses of eye protectors be kept clean. Continuous vision through dirty lenses can cause eye fatigue and become a contributory factor to accidents. Daily cleaning of eye protectors is recommended.

6.4.1.2 *Pitted or scratched lenses reduce vision and seriously reduce protection. They shall be replaced immediately.*

6.4.1.3 Replace headbands. Slack, wornout, sweat-soaked, knotted, or twisted headbands do not hold the eye protector in proper position. Visual inspection can determine when the elasticity is reduced to a point beyond proper function.

6.4.1.4 To prolong the life of eye protectors, they shall be placed in suitable cases or containers between periods of use.

6.4.2 Issue and Use. Protectors are a personal item and should be for the individual and exclusive use of the person to whom they are issued. If circumstances require reissue, *the protectors shall be thoroughly cleaned and disinfected as hereinafter described.*

6.4.3 Disinfection

6.4.3.1 *General.* When a per
protective equipment, it is reco
this equipment be cleaned and di
larly, without sharing by anothe
disinfected as herein specified.

6.4.3.2 *Procedure.* Thorough
surfaces with soap or suitable d
warm water. Carefully rinse all
or detergent. Completely immers
for 10 minutes in a solution of
hypochlorite, or quaternary ammo
in a strength specified by the m
a room temperature of 68°F. Rem
from solution and suspend in a c
air drying at room temperature,
air. Do not rinse because this
residual effect.

Ultraviolet disinfecting equip
utilized in conjunction with the
cedure above, when such equipmen
demonstrated to provide comparab

Protectors showing need for ex
should be disassembled to the ex
without tools, prior to the wash
infection procedure. Replace de
with new ones.

6.4.3.3 *Storage.* The dry pa
should be placed in clean, dust-
to protect them.

6.4 MAINTENANCE AND DISINFECTION OF EYE PROTECTORS

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place headbands. Slack, wornout, notted, or twisted headbands do not otector in proper position. Visual determine when the elasticity is int beyond proper function.

prolong the life of eye protectors, laced in suitable cases or containers of use.

nd Use. Protectors are a personal be for the individual and f the person to whom they are cumstances require reissue, *the l be thoroughly cleaned and disinafter described.*

6.4.3 Disinfection

6.4.3.1 *General.* When a person is assigned protective equipment, it is recommended that this equipment be cleaned and disinfected regularly, without sharing by another person unless disinfected as herein specified.

6.4.3.2 *Procedure.* Thoroughly clean all surfaces with soap or suitable detergent, and warm water. Carefully rinse all traces of soap or detergent. Completely immerse the protector for 10 minutes in a solution of modified phenol, hypochlorite, or quaternary ammonium compounds, in a strength specified by the manufacturer at a room temperature of 68°F. Remove protector from solution and suspend in a clean place for air drying at room temperature, or with heated air. Do not rinse because this will remove the residual effect.

Ultraviolet disinfecting equipment may be utilized in conjunction with the washing procedure above, when such equipment can be demonstrated to provide comparable disinfection.

Protectors showing need for extensive cleansing should be disassembled to the extent possible without tools, prior to the washing and disinfection procedure. Replace defective parts with new ones.

6.4.3.3 *Storage.* The dry parts or items should be placed in clean, dust-proof containers to protect them.

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FITTING OF GOGGLES AND SPECTACLES

A3.1 Cup Goggles

The first step in fitting cup goggles is to adjust the nose bridge. Both the ball and link- or plastic strap bridges of goggles are adjustable to accommodate the individual wearer. Both ty usually have some means for shortening or lengthening. In either case, to shorten or lengthen th instructions of the manufacturer should be followed. Chain, leather, or plastic not needed after should be cut off. The chain should be insulated to protect the nose of the wearer.

The proper procedure for adjusting headbands is to keep the band loose enough to slip two fi palm side down, without stretching. Headbands should be worn low and flat and approximately at t skull in order to hold goggles in a comfortable position. Most cup goggles are thinner and slant lower nasal sides, which makes for comfort as well as easy identification in getting them right s

A3.2 Spectacles

The first step in fitting spectacles is to determine the proper eye and bridge sizes. This using fitting samples and placing the sample spectacles on the nose to arrive at the proper size. rocker pads should fit flush against the sides of the nose without allowing the metal bridge of t rest on the nose bridge of the wearer. The small metal arms, to which the pearloid pads are atta readily adjusted by round nose pliers which are especially designed for this purpose. To fit the fortably over the ears, hold the spectacle firmly in one hand and shape the bow of the temple gra it slowly between thumb and forefinger of the other hand. Temples should be angled down from fra lenses will be perpendicular to the line of vision.

Prescription safety spectacles should be fitted only by qualified optical personnel.

FITTING OF GOGGLES AND SPECTACLES

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bridges of goggles are adjustable to accommodate the individual wearer. Both types of bridges
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. The chain should be insulated to protect the nose of the wearer.
rocedure for adjusting headbands is to keep the band loose enough to slip two fingers under it,
ithout stretching. Headbands should be worn low and flat and approximately at the base of the
hold goggles in a comfortable position. Most cup goggles are thinner and slanted away at the
, which makes for comfort as well as easy identification in getting them right side up.

ep in fitting spectacles is to determine the proper eye and bridge sizes. This is done best by
les and placing the sample spectacles on the nose to arrive at the proper size. The adjustable
d fit flush against the sides of the nose without allowing the metal bridge of the spectacles to
ridge of the wearer. The small metal arms, to which the pearloid pads are attached, can be
y round nose pliers which are especially designed for this purpose. To fit the temples com-
ears, hold the spectacle firmly in one hand and shape the bow of the temple gradually by drawing
thumb and forefinger of the other hand. Temples should be angled down from frame to ear so that
rpendicular to the line of vision.
safety spectacles should be fitted only by qualified optical personnel.

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WELDER CERTIFICATION

Welder certification, and the attendant testing, required for State contract work is administered Department of Transportation.

General Procedure:

- Contact the supervisor of welder certification at the nearest Department of Transport regional office to determine the time and location of that region's next certificatio test and the manner of filing an application.
- The welding is done in the presence of the Department's representative, who stamps th samples for identification. Welding samples must be prepared in the field —— they a not supplied by the regional office.
- The samples are sent to the materials testing laboratory where X-ray photographs are made and evaluated.
- If the inspection of the welds is affirmative a qualification card is sent to the regional supervisor, who personally presents it to the welder.

The card specifies the limits of qualification tested. A welder qualifying for unlimited thickne head position is, however, automatically qualified for everything else. The card is valid until calendar year of issue *provided that there is no lapse of 90 consecutive days in employment requi cation.* Certificate renewal is the responsibility of the welder, who must submit application wit ments verifying maintenance of qualifying skills and employment.

Questions regarding this program should be directed to:

Department of Transportation —— Structural Unit
Building 5, Sixth Floor
State Campus
Albany, New York 12226

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Department of Transportation —— Structural Unit
Building 5, Sixth Floor
State Campus
Albany, New York 12226

DEPARTMENT OF TRANSPORTATION —— REGIONAL OFFICES

Region #1:

F. J. Fuller
50 Wolf Road
Albany, N.Y. 12205

Telephone: (518)-457-7130

Region #2:

B. M. Evans
109 North Genesee Street
Utica, N.Y. 13503

Telephone: (315)-733-238
Ext. 40

Region #3:

E. E. Towlson
333 East Washington Street
Syracuse, N.Y. 13201

Telephone: (315)-474-5951
Ext. 322

Region #4:

B. F. Perry
Barge Canal Terminal
Rochester, N.Y. 14601

Telephone: (716)-325-48
Ext. 1

Region #5:

D. H. Ketchum
125 Main Street
Buffalo, N.Y. 14203

Telephone: (716)-842-4432

Region #6:

L. W. Hallenbeck
30 West Main Street
Hornell, N.Y. 14843

Telephone: (607)-324-19
Ext. 1

Region #7:

C. J. Lyman
444 Van Duzee Street
Watertown, N.Y. 13601

Telephone: (315)-782-2100
Ext. 209

Region #8:

M. N. Sinacori
P.O. Box 1315
Arlington Branch
19 Davis Avenue
Poughkeepsie, N.Y. 1260

Telephone: (914)-454-80
Ext. 2

Region #9:

J. C. Federick
71 Frederick Street
Binghamton, N.Y. 13902

Telephone: (607)-772-1540
Ext. 233

Region #10:

A. H. Emery
325 West Main Street
Babylon, N.Y. 11702

Telephone: (212)-823-54

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elephone: (607)-772-1540
Ext. 233

Region #2:

B. M. Evans
109 North Genesee Street
Utica, N.Y. 13503

Telephone: (315)-733-2384
Ext. 40

Region #4:

B. F. Perry
Barge Canal Terminal
Roches*er, N.Y. 14601

Telephone: (716)-325-4880
Ext. 13

Region #6:

L. W. Hallenbeck
30 West Main Street
Hornell, N.Y. 14843

Telephone: (607)-324-1900
Ext. 17

Region #8:

M. N. Sinacori
P.O. Box 1315
Arlington Branch
19 Davis Avenue
Poughkeepsie, N.Y. 12603

Telephone: (914)-454-8000
Ext. 231

Region #10:

A. H. Emery
325 West Main Street
Babylon, N.Y. 11702

Telephone: (212)-823-5450

WELDER QUALIFICATION TESTING PROCEDURE

When all applicants are assembled at the testing location and before any welding or preparati begins, the following notes should be read aloud to all participants:

1. The test plates must be prepared to the dimensions detailed in Figures 1, 2, 3 or 4, as a The entire weld will be radiographed, however, 1 inch at each edge of the 5-inch plate and 1 1/2 i edge of the 10-inch plate will be disregarded to allow for starting and stopping of the weld.

2. There are no requirements regarding the chemical or physical properties of the plates us However, it is to the welder's advantage to use good quality plate, manufactured to specification A-36 or A-441, or AISI Grades 1010 to 1020 inclusive.

3. It is suggested that the welder preheat the test plates, but preheats in excess of 300°F permitted.

4. It is suggested that the welder adjust his welding machine while practicing on a plate si and thickness, and preheated to the same temperature as the plate to be used in the test. It is t the welder's advantage to have to readjust the welding machine during the welding of the test pla

Welders being tested using Submerged Arc and Gas Metal Arc welding will *not be allowed* t machine settings after making the initial pass.

5. It is suggested that care be taken to clean properly between passes, and that this time b the test plate to cool to the desired preheat and interpass temperature so that machine adjustmen unnecessary.

6. Only 5/32 inch diameter electrodes, manufactured to the AWS-ASTM classification E 7018 r during the Manual Shielded Metal Arc Test.

The wire size and type, and the flux or shielding gas used for Submerged Arc or Gas Metal be those approved for use in the work.

7. It is suggested that all electrodes used in the test be dried for a minimum of 2 hours at not to the welder's advantage to use any electrode which has been allowed to cool more than 2 hour removed from the drying or storage oven. It is not to the welder's advantage to attempt to redry have been allowed to absorb moisture.

WELDER QUALIFICATION TESTING PROCEDURE

licants are assembled at the testing location and before any welding or preparation for welding ving notes should be read aloud to all participants:

plates must be prepared to the dimensions detailed in Figures 1, 2, 3 or 4, as applicable. ll be radiographed, however, 1 inch at each edge of the 5-inch plate and 1 1/2 inches at each h plate will be disregarded to allow for starting and stopping of the weld.

no requirements regarding the chemical or physical properties of the plates used in this test. the welder's advantage to use good quality plate, manufactured to specifications such as ASTM AISI Grades 1010 to 1020 inclusive.

gested that the welder preheat the test plates, but preheats in excess of 300°F. will not be

gested that the welder adjust his welding machine while practicing on a plate similar in size preheated to the same temperature as the plate to be used in the test. It is not generally to tage to have to readjust the welding machine during the welding of the test plate.

eing tested using Submerged Arc and Gas Metal Arc welding will *not be allowed* to change the fter making the initial pass.

gested that care be taken to clean properly between passes, and that this time be used to allow cool to the desired preheat and interpass temperature so that machine adjustments will be

inch diameter electrodes, manufactured to the AWS-ASTM classification E 7018 may be used Shielded Metal Arc Test.

size and type, and the flux or shielding gas used for Submerged Arc or Gas Metal Arc tests must for use in the work.

gested that all electrodes used in the test be dried for a minimum of 2 hours at 500°F. It is s advantage to use any electrode which has been allowed to cool more than 2 hours after being rying or storage oven. It is not to the welder's advantage to attempt to redry electrodes which to absorb moisture.

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8. The test plate detailed in Figure 3, if welded in the vertical position, will qualify th Manual Metal Arc Welding of fillet and groove welds in all positions except overhead, regardless thickness. In general, this one plate will be sufficient for all testing because the need for ov very limited by our designs.

It has been our experience that test plates one inch thick are easier to weld in the ver than 3/8-inch thick plates because of the ability of the thicker plate to dissipate the welding h we strongly recommend that the one-inch test plate be used and welded as a vertical groove weld.

9. The test plate detailed in Figure 4 is to be welded in the flat position *only* for the Ga Arc test or the Submerged Arc test. This will qualify the welder for flat groove welding and fla fillet welding.

10. At the completion of welding, the Engineer shall die stamp the test plate number and ide nessing agency, i.e. D.O.T. - District No.; O.G.S. - South Mall or District No.; or Testing Agenc to the State.

11. Machining may be used to remove excess weld metal but the final surface must be produced Either fiber disk or carborundum wheels will produce acceptable grinding results. No surface def gouges, nicks, etc.,) may remain.

Test plates reduced in thickness by more than 1/16 inch during the grinding process will unfit for testing.

12. A welder who has failed a test position and is being retested within 30 days must make t each position being retested unless evidence is supplied to the Engineer showing that the welder additional training. If acceptable evidence is supplied it must be noted on the test applicatio remarks, only one test weld then being required for each position being retested.

13. Grinding, air arc gouging, pneumatic chipping, or machining of any type will not be permi passes for any purpose.

Interpass slag chipping and cleaning must be accomplished by means of a hand-held nonme hammer and/or wire brush only.

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plate detailed in Figure 3, if welded in the vertical position, will qualify the welder for elding of fillet and groove welds in all positions except overhead, regardless of material eral, this one plate will be sufficient for all testing because the need for overhead welding is r designs.

en our experience that test plates one inch thick are easier to weld in the vertical position k plates because of the ability of the thicker plate to dissipate the welding heat. Therefore, end that the one-inch test plate be used and welded as a vertical groove weld.

plate detailed in Figure 4 is to be welded in the flat position *only* for the Gas Shielded Metal bmerged Arc test. This will qualify the welder for flat groove welding and flat and horizontal

mpletion of welding, the Engineer shall die stamp the test plate number and identity of the wit- e. D.O.T. - District No.; O.G.S. - South Mall or District No.; or Testing Agency under contract

may be used to remove excess weld metal but the final surface must be produced by grinding. or carborundum wheels will produce acceptable grinding results. No surface depressions (lines, .,) may remain.

es reduced in thickness by more than 1/16 inch during the grinding process will be rejected as

who has failed a test position and is being retested within 30 days must make *two* test welds in g retested unless evidence is supplied to the Engineer showing that the welder has received g. If acceptable evidence is supplied it must be noted on the test application form under test weld then being required for each position being retested.

air arc gouging, pneumatic chipping, or machining of any type will not be permitted between oose.

slag chipping and cleaning must be accomplished by means of a hand-held nonmechanical chipping brush only.

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POSITION OF TEST WELDS

TEST POSITION	POSITION & TYPE WELD QUALIFIED	
	GROOVE WELD TEST PLATE UNLIMITED* & LIMITED** THICKNESS	FILLET WELD ONLY TEST***
FLAT	FLAT GROOVE; FLAT & HORIZONTAL FILLET	FLAT FILLET
HORIZONTAL	FLAT & HORIZONTAL GROOVE; F & H FILLET	FLAT & HORIZONTAL F
VERTICAL	F, H & V GROOVE; F, H & V FILLET	F, H. & V. FILLET
OVERHEAD	F & OH GROOVE; F, H & OH FILLET	F, H. & OH FILLET

*Qualifies for welding groove and fillet welds on material of unlimited thickness.

**Qualifies for welding groove welds in material not over 3/4" thick and fillet welds material of unlimited thickness.

***Qualifies for welding fillet welds only, on material of unlimited thickness.

POSITION OF TEST WELDS

POSITION & TYPE WELD QUALIFIED	
GROOVE WELD TEST PLATE UNLIMITED* & LIMITED** THICKNESS	FILLET WELD ONLY TEST***
FLAT GROOVE; FLAT & HORIZONTAL FILLET	FLAT FILLET
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F, H & V GROOVE; F, H & V FILLET	F, H. & V. FILLET
F & OH GROOVE; F, H & OH FILLET	F, H. & OH FILLET

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fies for welding groove welds in material not over 3/4" thick and fillet welds on
ial of unlimited thickness.

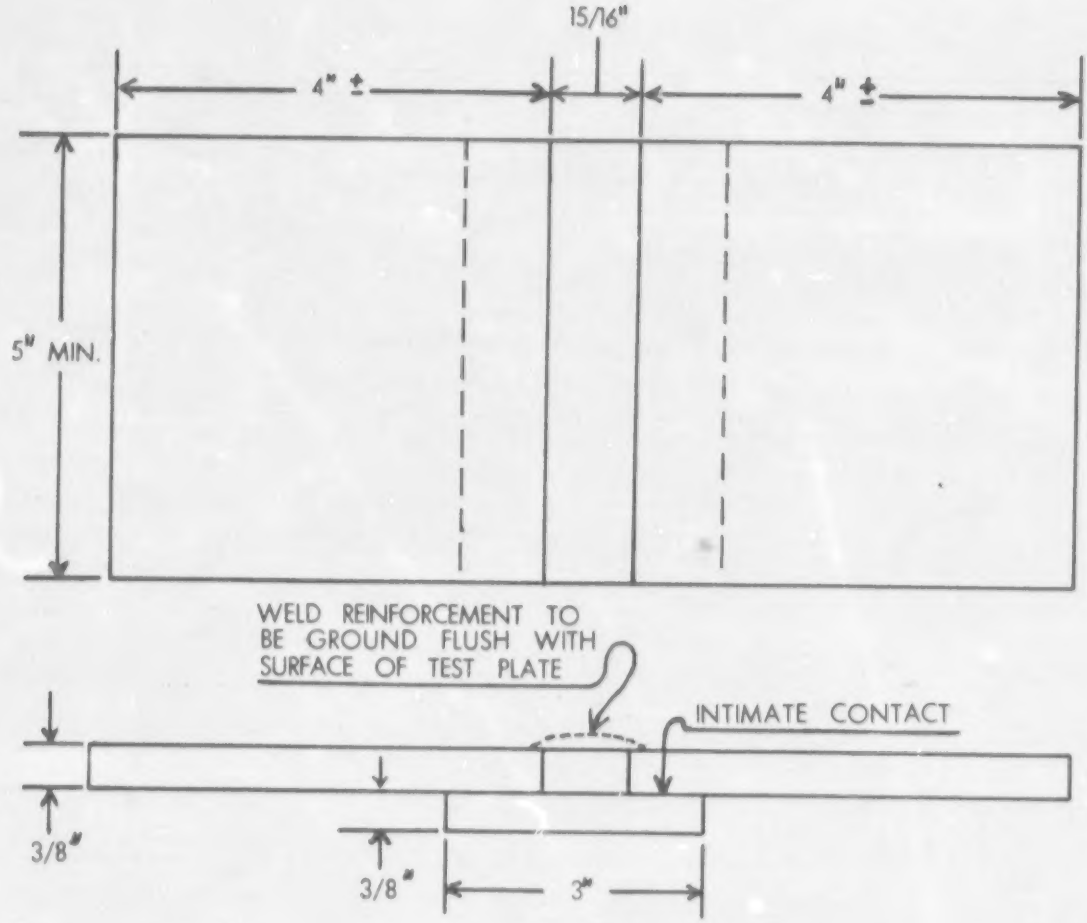
fies for welding fillet welds only, on material of unlimited thickness.

8

18A

FILLET WELDS ONLY

FIGURE 1



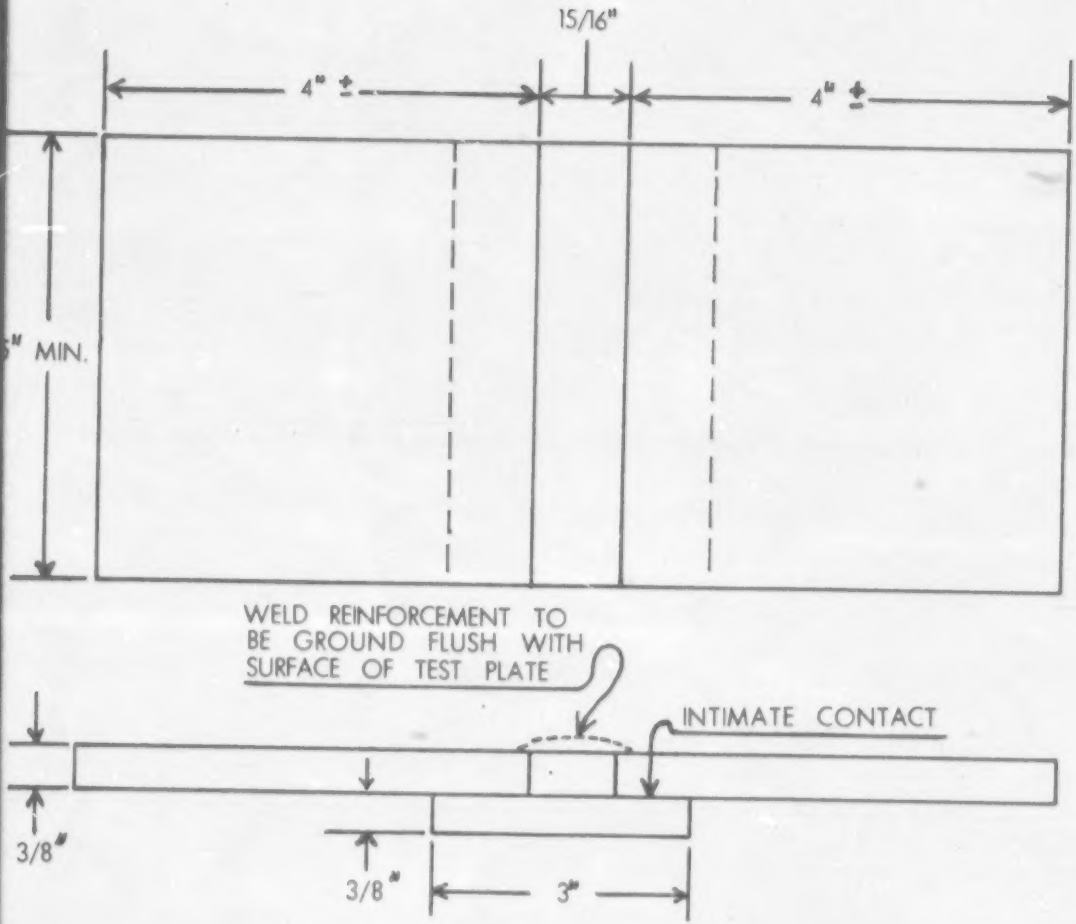
NOTES:

1. Do not remove backing plate.
2. All plate surfaces within the area of the backing plate must be free of mill scale depressions. This includes the top and bottom of the test plate and the backing pl

49

FILLET WELDS ONLY

FIGURE 1



t remove backing plate.

late surfaces within the area of the backing plate must be free of mill scale and surface ssions. This includes the top and bottom of the test plate and the backing plates.

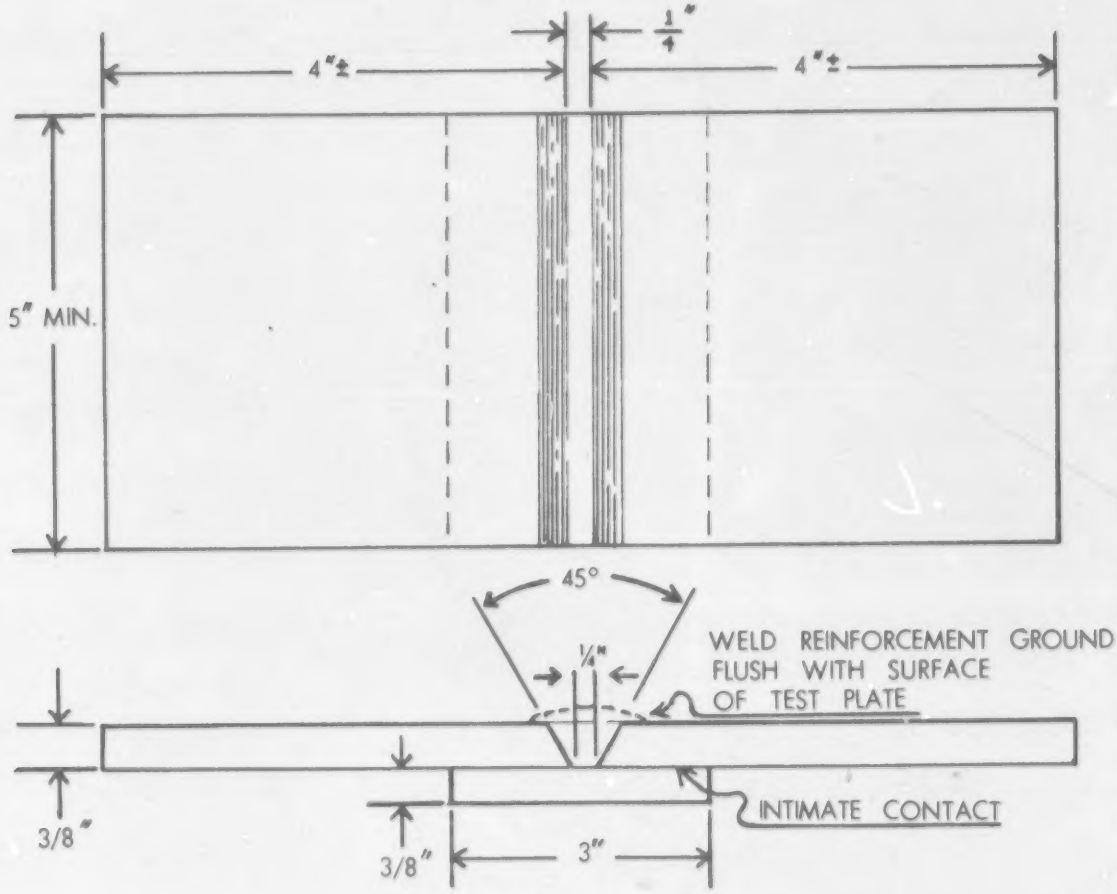
49

19A

GROOVE WELDS - LIMITED THICKNESS

FILLET WELDS - UNLIMITED THICKNESS

FIGURE 2



NOTES:

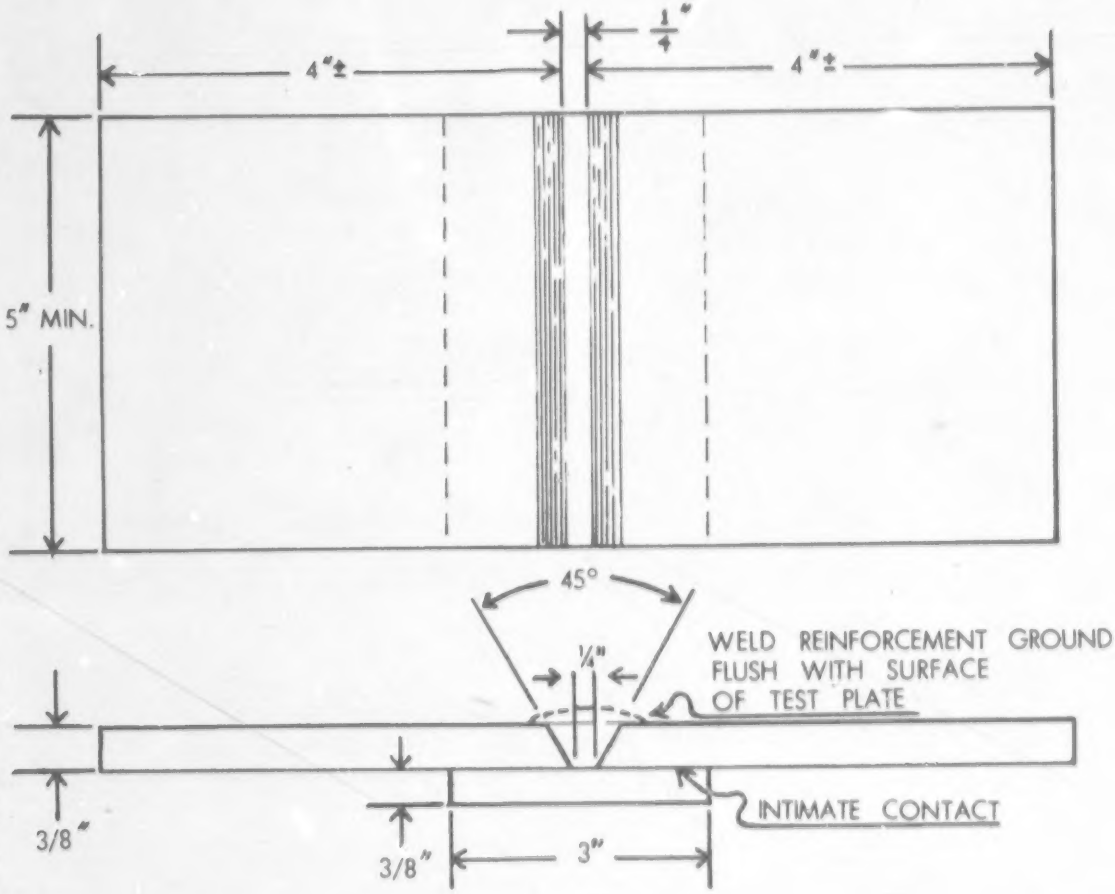
1. Do not remove backing plate.
2. All plate surfaces within the area of the backing plate must be free of mill scale depressions. This includes the top and bottom of the test plates and the backing

50

GROOVE WELDS - LIMITED THICKNESS

FILLET WELDS - UNLIMITED THICKNESS

FIGURE 2



not remove backing plate.

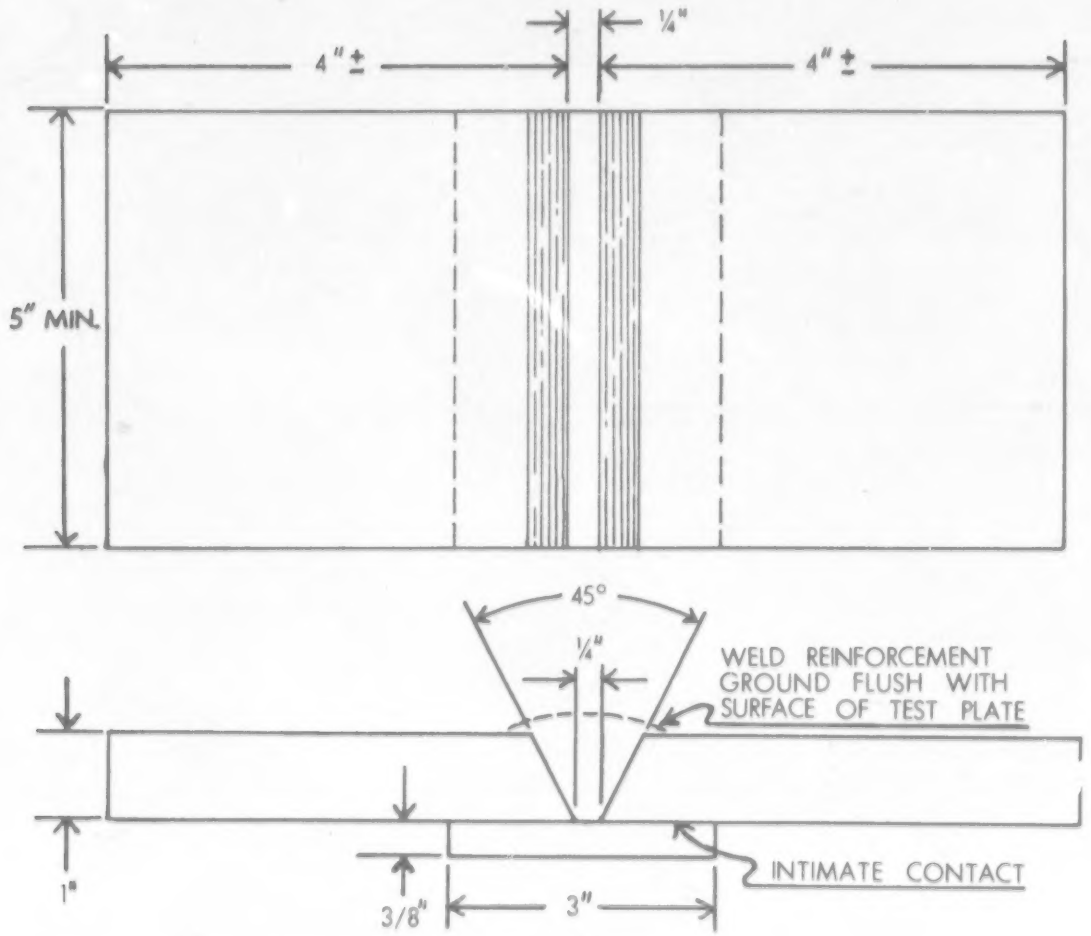
plate surfaces within the area of the backing plate must be free of mill scale and surface ressions. This includes the top and bottom of the test plates and the backing plate.

50A

GROOVE WELDS - UNLIMITED THICKNESS

FILLET WELDS - UNLIMITED THICKNESS

FIGURE 3



NOTES:

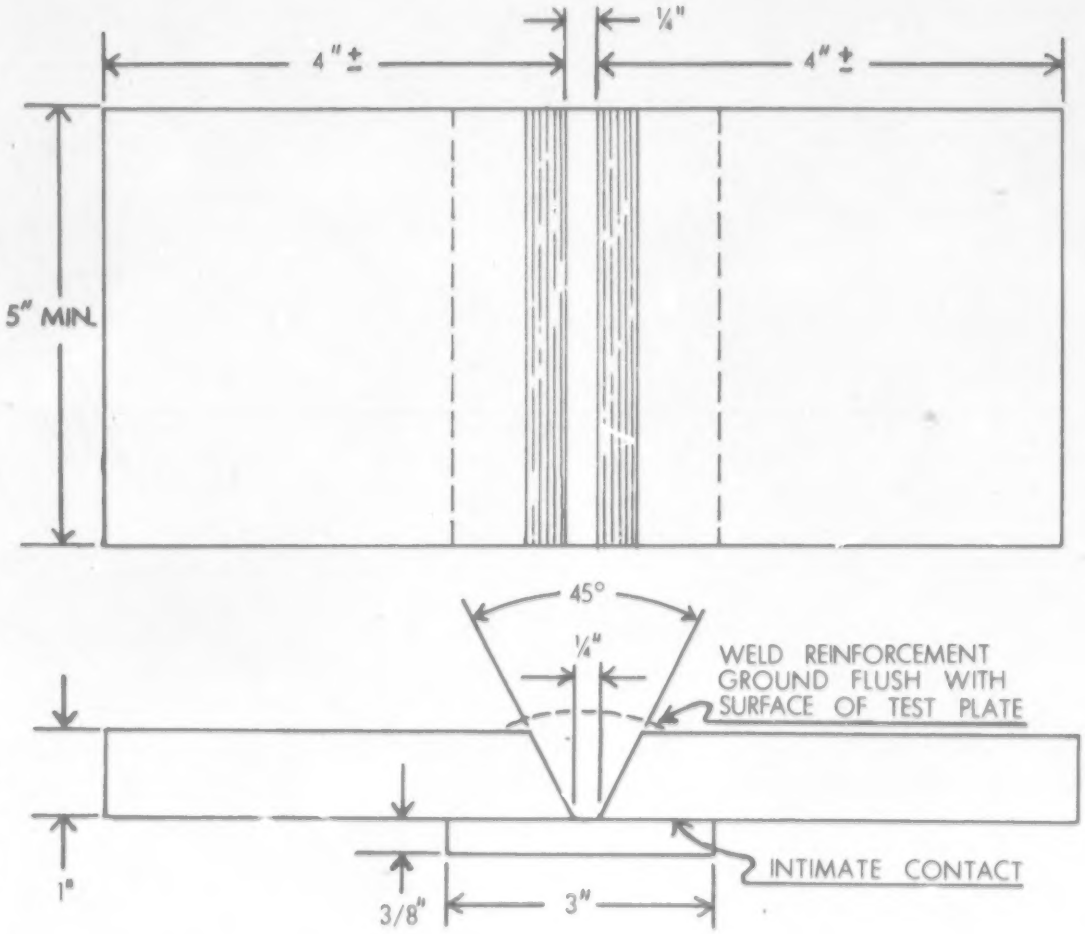
1. Do not remove backing plate.
2. All plate surfaces within the area of the backing plate must be free of mill scale depressions. This includes the top and bottom of the test plates and the backing

51

GROOVE WELDS - UNLIMITED THICKNESS

FILLET WELDS - UNLIMITED THICKNESS

FIGURE 3



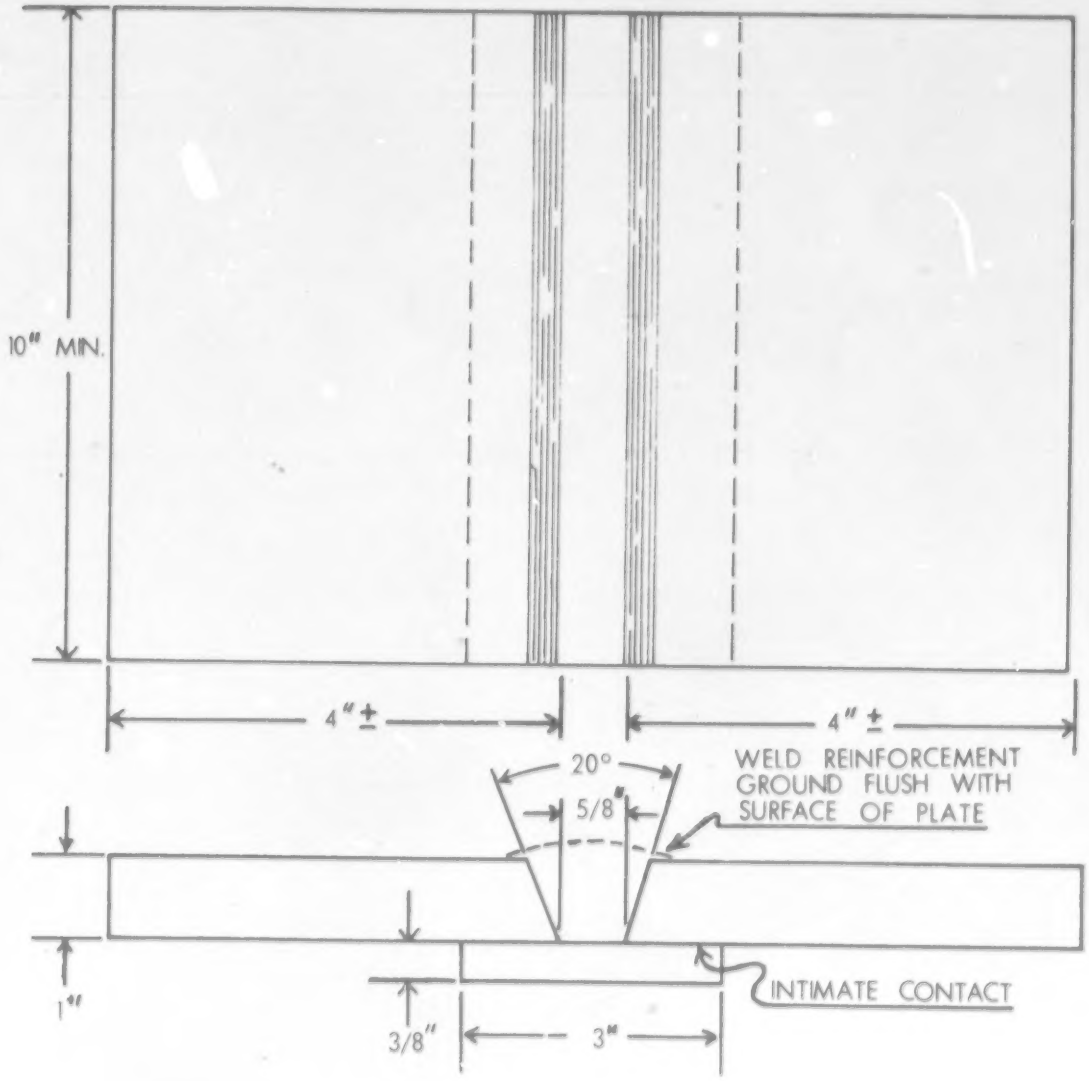
ot remove backing plate.

plate surfaces within the area of the backing plate must be free of mill scale and surface essions. This includes the top and bottom of the test plates and the backing plate.

51A

SEMI-AUTOMATIC GAS SHIELDED METAL ARC & SEMI-AUTOMATIC SUBMERGED ARC PROCESSES

FILLET and GROOVE WELDS, UNLIMITED THICKNESS



FIG

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1. Do not remov
2. All plate su
area of the
must be free
and surface
This include
bottom of th
and the back

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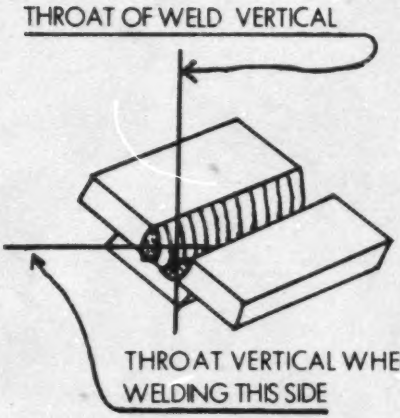
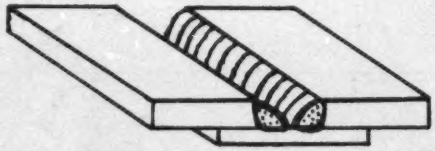
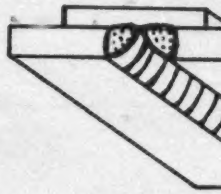
POSITIONS of TEST PLATES
for FILLET WELDS



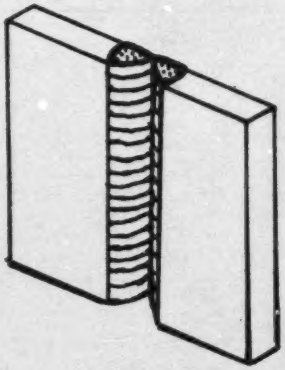
FLAT POSITION



HORIZONTAL POSITION

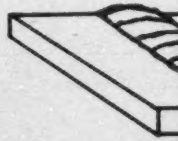


OVERHEAD



VERTICAL POSITION

FILLET WELD TEST ONLY



SHADED PORTION MAY BE WELDED
IN ANY POSITION AFTER COMPLETING A
5/16" FILLET WELD ON EACH SIDE WHILE
WELDING IN THE POSITION BEING TESTED.

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IS SIDE

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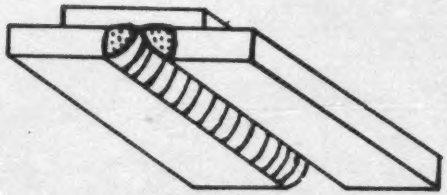
OSITION

POSITIONS of TEST PLATES
for FILLET WELDS

HORIZONTAL POSITION



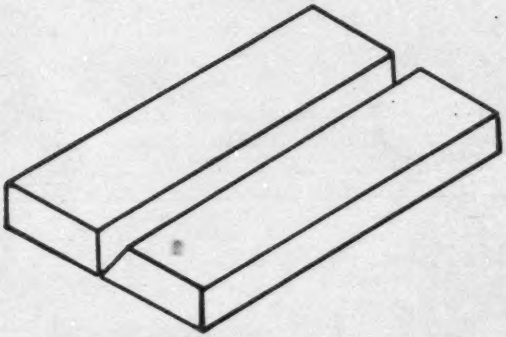
OVERHEAD POSITION

FILLET WELD TEST ONLY

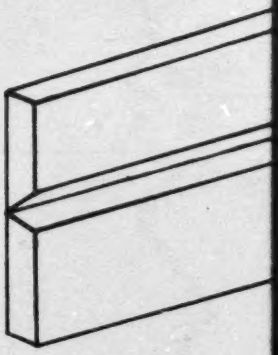
SHADED PORTION MAY BE WELDED
IN ANY POSITION AFTER COMPLETING A
5/16" FILLET WELD ON EACH SIDE WHILE
WELDING IN THE POSITION BEING TESTED.

53A

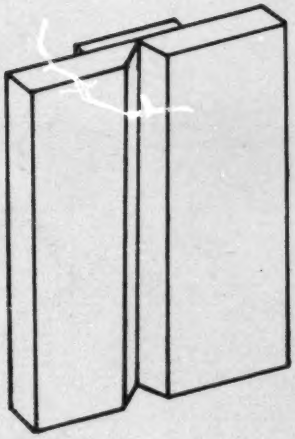
POSITIONS of TEST PLATES
for GROOVE WELDS



FLAT POSITION



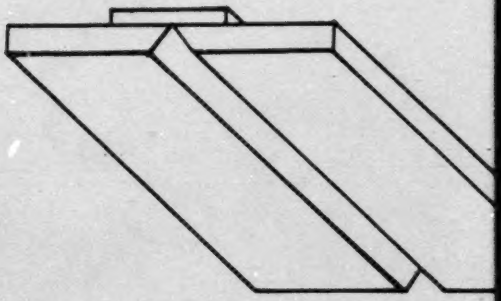
HORIZONTAL POS



VERTICAL POSITION

NOTE:

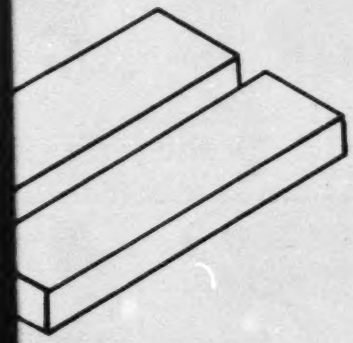
Test Plates must remain in these positions until welding is complete.



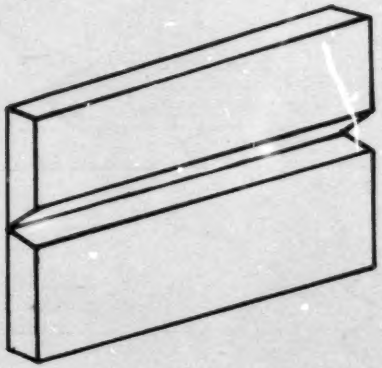
OVERHEAD POSITION

57

POSITIONS of TEST PLATES
for GROOVE WELDS



POSITION

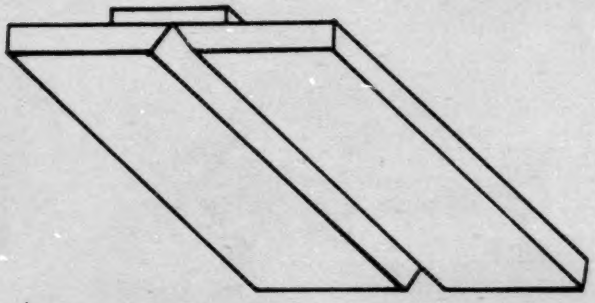


HORIZONTAL POSITION

ERTICAL POSITION

NOTE:

Test Plates must remain in these positions until welding is complete.



OVERHEAD POSITION

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54A

"Forms Patented by HCR Co."

BR 244 (2/69)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION
WELDER QUALIFICATION TEST

District: _____
Project: _____

Lab. Test No. _____
Date Received _____

Name of Welder: _____ Social Sec. No. _____
Address: _____
Employer's Name: _____

Welding Processes

Manual Metal Arc Welding: Electrode Mfg. _____ Diam. 5/32" AWS–ASTM Classification E7018

Semi-Auto. Gas-Metal Arc Welding: Wire Mfg. _____ Diam. _____ AWS–ASTM Classification _____
Shielding Gas _____ Gas Flow Rate _____ c.f.h.

Semi-Auto. Submerged Arc Welding: Wire Mfg. _____ Diam. _____ AWS–ASTM Classification _____
Flux Mfg. _____ AWS–ASTM Flux Classification _____

Machine Used

Ampere Rating: _____ AC _____ DC _____ Polarity: Neg. _____ Pos. _____
Serial Number: _____ Manufactured By: _____

List the following additional material for semi-automatic welding processes:

1) Ampmeter Reading during Welding _____
2) Voltmeter Reading during welding _____
3) Rate of Welding - inches per Minute _____

Remarks: _____

WELD TYPE	POSITION	PLATE THICK.	MARK	SW NO.	LABORATORY TEST RESULTS

Tests Conducted By: _____ Title: _____

Identification Mark: _____ Date of Tests: _____

INSTRUCTIONS
WHITE & GREEN – to Materials Bureau
YELLOW – to Bridge Office
PINK – retain

_____
Bridge Engineer

FOR MATERIALS BUREAU USE ONLY

No. of Samples: _____ X-Ray Plate No.: _____

X-Rayed By: _____ Date: _____

Reviewed By: _____ Date: _____

Checked & Reported By: _____ Date: _____

48

55

BD 36b (9/71)

STATE OF NEW YORK
DEPARTMENT OF TRANSPORTATION

No. _____

_____

Social Security No. _____

has qualified for using the following welding processes to the extent shown on the reverse side hereof:

- ☐ Manual Metal Arc Welding
- ☐ Semiautom. Flux Cored Arc Welding (with CO_2 shield)
- ☐ Semiautomatic Submerged Arc Welding (Wire Dia. ____)

Qualification expires on December 31 following the date below unless otherwise revoked.

Date: _____

_____
Deputy Chief Engineer (Structures)

SAMPLE

_____
Signature of Welder

Qualification is granted on the basis of X-Ra
test welds interpreted to the N.Y.S. Radiograp

NOT VALID WHERE PUNCHE

SAMPLE

WELDING PROCESS	FILLET WELDS				GROOV ¾" max. thickness			
	Position				Position			
Manual	F	H	V	O	F	H	V	O
Gas-Shield	F	H	V	O	F	H	V	O
Sub-Arc	F	H			F			

56

WELDER CERTIFICATION CARD (ENLARGED)

TATE OF NEW YORK
ENT OF TRANSPORTATION
o. _____

urity No. _____

using the following welding processes to the
reverse side hereof:
Arc Welding
x Coated Arc Welding (with CO_2 shield)
Submerged Arc Welding (Wire Dia. ____)
es on December 31 following the date below
voked.

Deputy Chief Engineer (Structures)

SAMPLE

Signature of Welder

Qualification is granted on the basis of X-Ray examination of test welds interpreted to the N.Y.S. Radiographic Specification.

NOT VALID WHERE PUNCHED

WELDING PROCESS	FILLET WELDS				GROOVE WELDS: ¾" max. thickness				GROOVE WELDS: unlimited thickness			
	Position				Position				Position			
Manual	F	H	V	O	F	H	V	O	F	H	V	O
Gas-Shield	F	H	V	O	F	H	V	O	F	H	V	O
Sub-Arc	F	H			F				F			

56

56A

FILLET and GROOVE WELDS, UNLIMITED THICKNESS

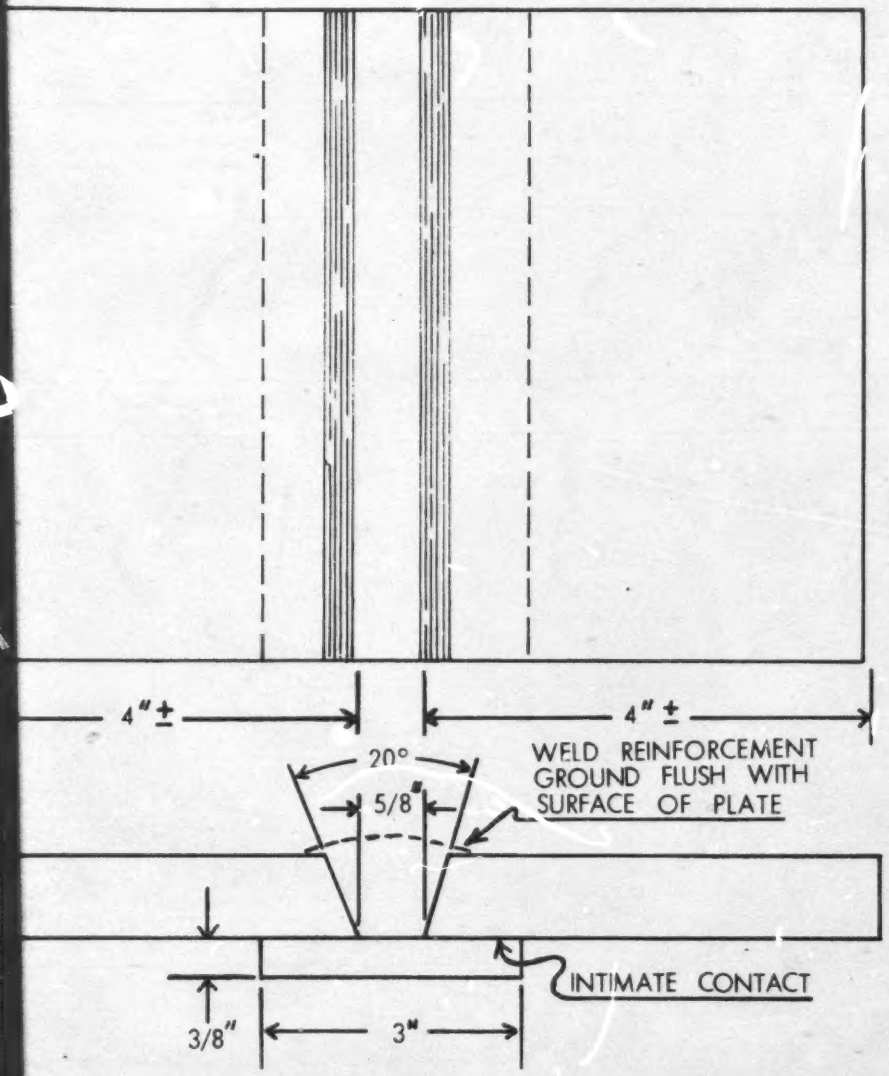

FIGURE 4

NOTES:

1. Do not remove backing plate.
2. All plate surfaces within the area of the backing plate must be free of mill scale and surface depressions. This includes the top and bottom of the test plates and the backing plate.

52A